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January 24, 1935

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Engineering News-Record

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Flood Control on San Gabriel River

First of two articles on the engineering problems involved in controlling the floods in the major stream that menaces the Los Angeles District

ALSO IN THIS ISSUE: **Concrete Experimental Work Under Desert Conditions . . . Notes on Design of Small Log Bridges . . . Allotments for Federal Mapping . . . Bituminized Concrete Casing for Piles in Sea Water . . . Maintaining Vancouver's Submerged Pipe Lines . . . Methods and Cost of Filling for Highways Over Swamps.**

A rock-fill dam (No. 1) is to be built across the San Gabriel canyon at this point. Abutment clearing at left; beyond a quarry is being opened

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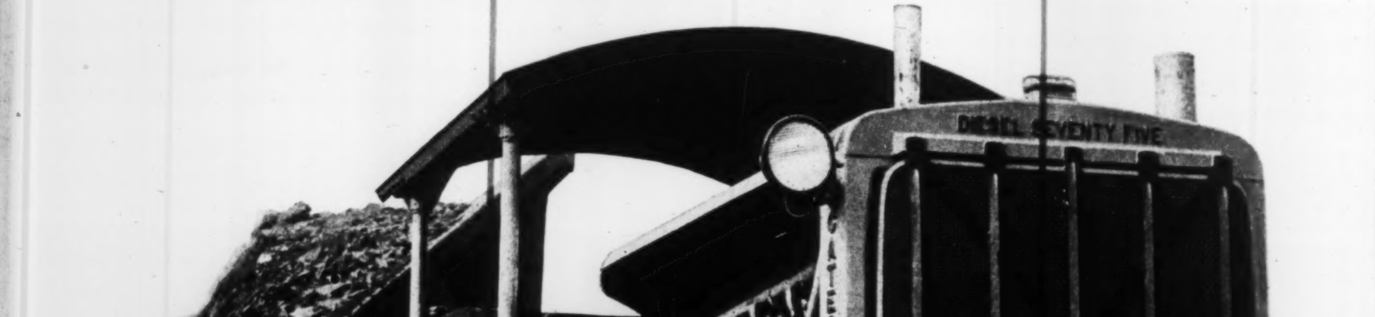
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The President's Plan Needs the Construction Industry

SINCE the President presented to Congress his outline of a new public works program little authoritative information has been released as to details of procedure. It is evident, however, that the new plan offers possibilities of great good and of equally great harm and that every element of the construction industry, both professional and industrial, should devote to the pending legislation its best thought and early action.

All who have at heart the welfare of the nation and of the industry will agree with the President that federal relief must give way to employment and that government should seek to provide jobs for the 3,500,000 employables now on relief pending their absorption into private employment. They will agree, too, with the principles thus far laid down to govern emergency employment, i.e., that all projects should be of long-term value, that compensation should be more than a dole yet not higher than local prevailing wages and that projects compete as little as possible with private enterprise and be tapered off as private employment becomes increasingly available.

But every precaution must be exercised to prevent such an emergency program from scuttling the organized construction industry. Construction and its dependent industries are vital factors in the national economy; it would be futile to absorb the unemployed of other industries by methods that would undermine it. To prevent this, the largest possible volume of construction, public as well as private, must be handled through the architectural, engineering and contracting organizations that have been established by private enterprise through the investment of private capital. Thus only can the construction industry do its part in behalf of recovery and thus only can the President's program proceed without grievous waste of public funds and of the human values the President would conserve.

More precisely, the execution of the emergency program should meet the following specifications:

(1) Emergency construction should not invade any field that private capital is able and willing to enter at this time.

(2) A normal volume of non-federal public construction should be encouraged by federal loans and grants as now provided by the PWA.

(3) Normal works, whether federal or non-federal, heretofore prosecuted by normal contracting methods, should not be handled otherwise as part of an emergency program.

(4) On all works undertaken under such a program, whether federal or non-federal, normal or emergency, every effort should be made to follow normal procedure by having private architects and engineers prepare plans and specifications and by awarding contracts to qualified contractors rather than through governmental day-labor employment.

(5) On all public construction wages should not exceed the local prevailing scales for comparable work in private industry and contractors and others engaged on such work should be free to use their mechanical equipment and hire their employees on the basis of fitness for the work to be done; there should be no interference to favor primitive methods or to convert employment into a disguised dole.

(6) Wherever emergency construction cannot be handled by normal contracting methods and day-labor must be used, the work should be handled by an existing bureau or department having competent administrative personnel; this will avoid the needless creation of wasteful overhead and political bureaucracy.

If these requirements be not substantially met, the President's program will tend to dry up the supply of public construction on which the industry now depends, to waste public funds through improvised agencies and to put a premium on political manipulation. On the other hand, their observance will tend to conserve the established professional and industrial organization of the industry, to insure the expenditure of funds under the supervision of experienced staffs and to prevent political exploitation of the unemployed.

If the existing organization of the construction industry were allowed to disintegrate, even though the individuals be directly employed by governmental agencies, an element of incalculable value to the national economy would be destroyed and a powerful influence for efficiency in the expenditure of emergency funds would be lost. On every count it is evident that Congress can make the most of the emergency appropriation by requiring that it be expended, so far as practicable, through the normal channels and by the normal methods of the construction industry.

Willard Chevalier

ENGINEERING NEWS-RECORD

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In the News:

The Second PWA low-rent housing project reached the building stage when bids were called Jan. 17 on the University housing development in Atlanta, Ga.

Water-right Controversies on the North Platte River have resulted in Solicitor Margold, Department of the Interior, rendering an opinion that the government cannot safely proceed with the construction of the Casper-Alcova irrigation project.

Contract for driving the 12.7 mile San Jacinto Tunnel on the Colorado River Aqueduct, held by the Wenzel and Henoch Construction Co., has been suspended by the Metropolitan Water District as a result of being "unreasonably and unnecessarily delayed."

Concrete Work on the south pier of the Golden Gate Bridge has been completed, grinding for the base is under way, and erection of the tower steel will be started within a month.

"Slums Cannot Be Eradicated except on the basis of a government subsidy," said Secretary Ickes before the meeting of the National Housing Conference, Jan. 19.

The Ohio State Relief Commission is planning flood-control and water-conservation projects in the form of small reservoirs, with an aggregate cost of $3,633,000.

All Bids for furnishing cement for five dams on the Muskingum Valley project have been rejected as too high. Nineteen bidding firms submitted identical bid prices.

ANNUAL REVIEW NUMBER

The annual survey number, appearing Feb. 7, will present the picture of construction during 1934 and its 1935 prospects. Included also will be notes on the status of major engineering projects. The feature of the issue will be a group of articles contributed by high authorities in engineering and contracting who are leaders in the code administration. Stephen F. Voorhees, chairman of the construction code authority, Sullivan W. Jones, chairman of the construction planning and adjustment board charged with developing improved labor relations, A. E. Horst, of the general contractors, Gorden P. Marshall, of the subcontractors, and Carlton S. Proctor, of the engineers code groups, contribute to the discussion. As a broad background to these views, an analysis of the NRA code system as a whole and its relation to economic recovery will be presented by the well-known economist A. J. Hettinger, Jr. The housing problem will be discussed by Arthur C. Holden, architect, long prominent in housing planning and betterment.

The great 1934 drought is the subject of a detailed factual review included in this issue. What is the business outlook? What were the significant events and changes in the economic field and what are their effects? David Dillman, economist, will outline the business picture.

In This Issue:

Flood Control on the San Gabriel River has been the major problem of the Los Angeles County Flood Control District since its formation ten years ago. The abandonment of one dam and the present cessation of work on a second structure indicate difficulties encountered. The history of the planning and construction work during the decade are reviewed.

Concrete on the Colorado River Aqueduct will be subjected to severe desert conditions, and an extensive testing program has been started by the District to determine the basis for concrete design and curing procedure.

Vancouver, B. C., has had unusual experience in the construction and maintenance of submerged pipe lines in tidal waters. Results of this experience and the methods used in salvaging the lines across the First Narrows are described.

Highway Construction and maintenance across swamps have been long-standing problems in Michigan, and a summary of recent practice and figures on costs are outlined.

Problems of Concrete Exposure in sea water were met by using asphalt-impregnated concrete slabs on concrete bearing piles on the Bellamy River Bridge in New Hampshire.

Wood-Stave Pipe was first installed in the Denver water-supply system 50 years ago, and the service records cover the 45-year life span of the early installations. The experience records include valuable data.

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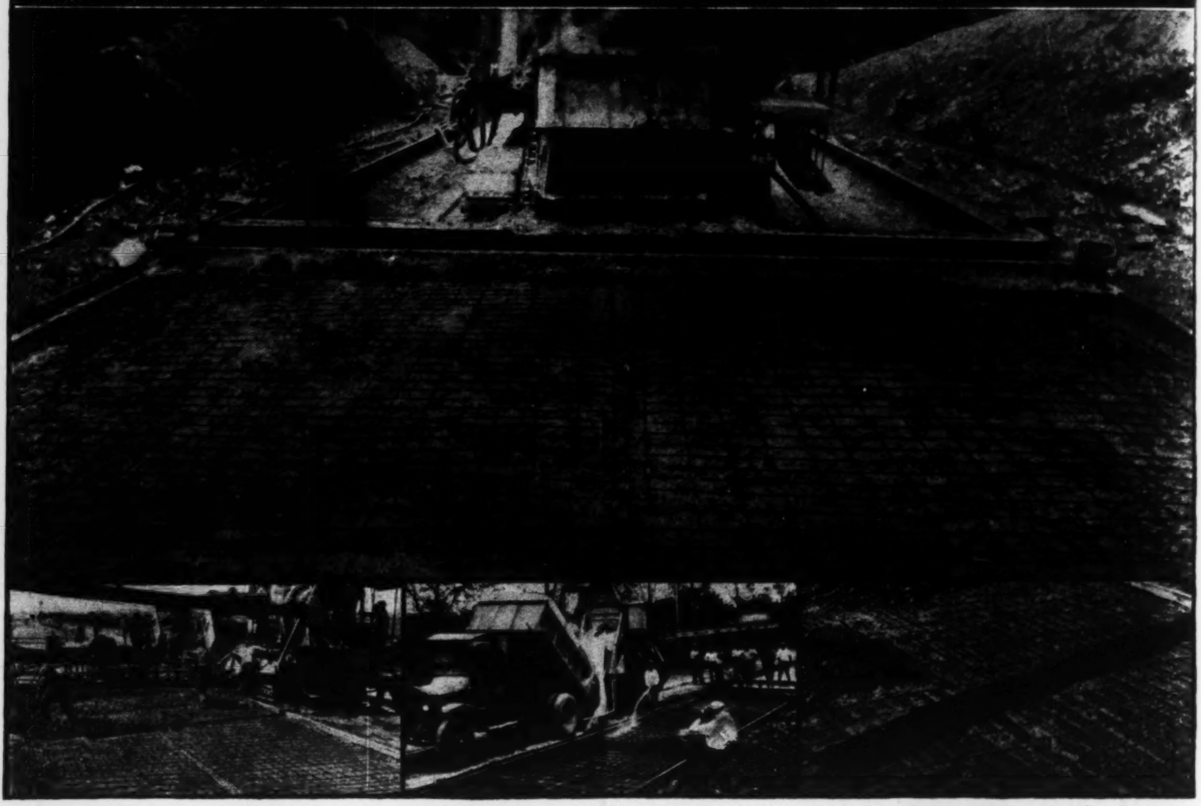

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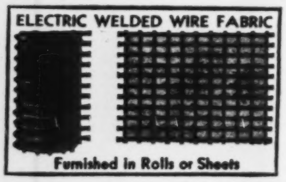

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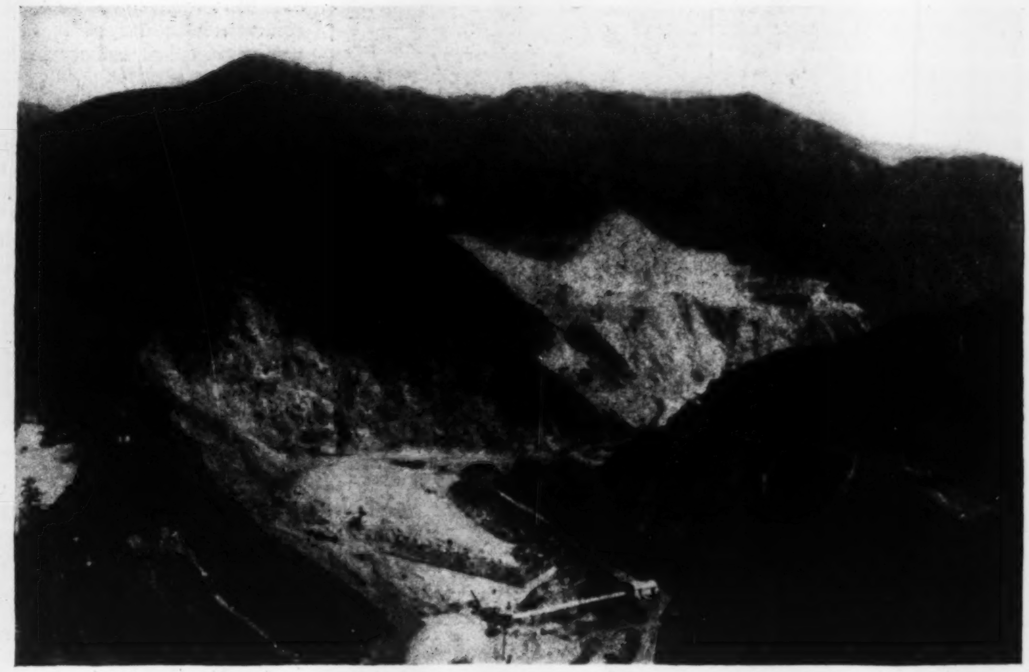

FIG. 1—SAN GABRIEL RIVER CANYON at the site of No. 1 dam. The concrete toewall is shown in the foreground, and the left abutment stripping is evident. Streamflow is diverted through the tunnel, whose upstream portal is visible at the extreme left. In the background the extensive face of the No. 10 quarry is shown as a white area.

San Gabriel River Flood Control

A review of the decade of planning and the construction work designed to control and conserve the floods of the San Gabriel River in southern California since the establishing of the Los Angeles County Flood Control District in 1924

A SEMI-ARID CLIMATE subject to infrequent but severe storms, a back country rising abruptly into rugged mountains with 10,000-ft. peaks, and an ever-increasing urban and agricultural development on the flood-plain areas combine to make the Los Angeles metropolitan region peculiarly vulnerable to floods. A disastrous flood in 1914 initiated public thinking which resulted in the formation of the flood control district in 1924 and work has been active during the past decade. The major problem has been on the San Gabriel River, and the recent change in engineering administration and subsequent decision to restudy the design of the major control dam make this review of the program of particular value. A description of the rockfill dam No. 2, its subsidence and the subsequent repair program will appear in a coming issue.—EDITOR.

FLOOD PROTECTION for properties valued at millions of dollars and conservation of the scanty natural water supply available for a population of some 2,500,000 in Los Angeles County were major objectives in the formation of the Los Angeles County Flood Control District organized in 1924. The floods and the stormwater damage of 1914 in Los Angeles County doubtless were factors in getting the move started, although it was not until a decade later that the organization was completed and a large bond issue was voted. The flood-control program was laid out to include work that could be done with the $35,300,000 bond issue approved by the voters in 1924. Of this total sum, $25,000,000 was allocated to a concrete dam of unprecedented size to be built at the Forks site in San Gabriel Canyon.

In the decade since that bond issue was voted some thirteen dams of various types have been completed and are rendering effective service in different parts of the district. Misfortune has attended the work of the district in the San Gabriel Canyon, however. Although large sums have been spent there on two storage dams, both of these structures are still incomplete, and both are in difficulties at the present time.

Under new engineering management since the appointment of Samuel M. Fisher as chief engineer on Sept. 20, 1934, the situation in San Gabriel Canyon has been studied from new angles; reconstruction of the facing and placement of additional yardage have been undertaken on dam No. 2. Early in November work under contract on dam No. 1 was stopped pending complete redesign of the structure and application to the state engineer for permit to construct according to the new plans. The outcome of these new moves will be matters for future announcement. In the following are presented some of the outstanding events since the work began and some of the highlights of the situation as it now stands.

The flood-control plan

The general plan of flood control included temporary retention of flood peaks in surface reservoirs, small debris dams to hold back materials carried in suspension, spreading areas capable of absorbing regulated flows (usually on delta cones at the mouths of canyons) and, finally, storage in the underground gravels. Incidental to these works have been certain channel improvements and revetment of flood-channel banks. By far the most important part of the surface-reservoir construction was to be in San Gabriel Canyon; it was with this in mind that more than two-thirds of the total bond issue was assigned to structures there.

Hydrology and the Flood Menace—The area included in the flood control district is 2,757 square miles, which naturally divides itself into a mountain area of 1,586 square miles and valley land totaling 1,171 square miles. The mountain area, an extremely rough and rugged terrain rising to elevations of 10,000 ft., lies north of the centers of population and separates the ocean slope from arid or desert lands on the opposite side of the mountains. The south side of the mountain area is cut by deep and rugged canyons that terminate in large delta cones at the edge of a broad plain and valley area gently sloping toward the ocean and including the Los Angeles metropolitan region, the city of Long Beach and residential areas between that city and Santa Monica.

With wide variation in rainfall from point to point and season to season, streamflow characteristics are typically flashy, and there are long intervals of no runoff at all. An example of the heavy rainfall was the storm on New Year's Day, 1934, which caused enormous damage and recorded a precipitation of 17 in. in 30 hours (*ENR,* April 5, 1934, p. 439). Where such torrential downpours and high runoff figures affect an area devoted to concentrated agriculture, including truck gardening and citrus growing, flood-control measures become highly important.

High land values, also, place a premium on the storage of floodwaters for use during the long periods of low flow. The annual waste into the ocean in this district is about 120,000 acre-ft., much of which could be stored for valuable uses during the dry seasons. A conservative valuation of this flood runoff in southern California is about $20 per acre-ft. In the score of years since the 1914 floods the valuation of property in the county has risen from $800,000,000 to $4,500,000,000; this indicates not only the greater amount of damage likely to be done by floods but also reflects the proportionally larger area of paved streets and roofs that give an almost complete runoff and add to the floods from the mountain areas.

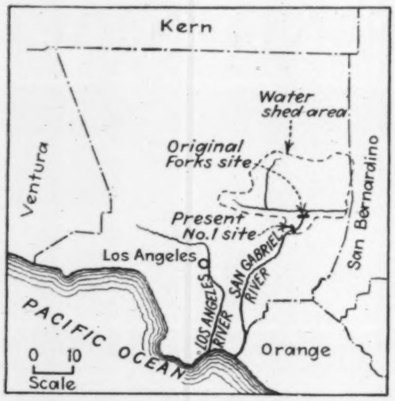

FIG. 2—LOS ANGELES COUNTY, showing location of San Gabriel River, mountain-catchment area, abandoned Forks site and present No. 1 site. The northern section of the county is not a part of the flood-control district.

The foregoing are some of the considerations which led to the confidence with which the flood-control program was laid out and large funds made available by the 1924 bond issue.

San Gabriel Dam No. 1

After the originally projected 500-ft. concrete dam at the Forks site, for which bond funds were allocated, was abandoned because of bad rock in the abutments, the plan was changed to provide a rockfill dam at another site. The latter is an essential part of the present program; it is now hoped to complete such a dam and also dam No. 2 with the $13,000,000 remaining from the original $25,000,000 allocated for this major feature of the flood-control program. The checkered history of expenditures in San Gabriel Canyon and how these extensive changes in original plans came about are outlined in the following.

The original designation in the bond issue of a concrete dam at the Forks site stipulated the height and reservoir capacity to be obtained. For several years controversy ranged over exact location (influenced by Pasadena's proposal of a storage dam lower down in the same canyon) and also over the question of whether to build a low or a high dam. The dam finally selected by court decree was to be 500 ft. high, to store 240,000 acre-ft., to contain about 4,000,000 cu.yd. of concrete, and to cost about $22,500,000. Work was begun in March, 1929, under a contract that called for completion of the dam in six years.

While excavation was still under way a serious earth slip at the west abutment resulted in holding up the work for a further study of foundations. Before the end of 1929 the contract for constructing the dam was canceled. In the welter of litigation that followed, the county paid the contractors almost $800,000 as "damages" for the abrogated contract, later one of the supervisors was convicted of bribery in connection with this settlement. Suits to recover for the county moneys paid to the contractors are still pending.

Surveys for a new No. 1 dam site developed what was thought to be a safe and satisfactory location just above the high reservoir line of Morris Dam, constructed by the city of Pasadena lower down in San Gabriel Canyon. At this site it was proposed to build a rockfill dam; the courts held that this could be done legally with the funds originally intended for expenditure at the Forks site. The structure was designed to store 62,000 acre-ft., to have a height of 300 ft. above streambed, a crest length of 1,670 ft., and a base thickness of 900 ft. (streambed level).

After the rejection of all bids submitted in two successive calls for bids on this rockfill structure, a contract was awarded in the latter part of 1932 to the West Slope Construction Co., the present contractor on dam No. 1, on a bid of $8,600,527 (exclusive of spillway). Under this contract the district is to furnish steel, cement and valves. The contract includes 120,000 cu.yd. of concrete and gunite. The expectation was that the total cost of the structure would be about $10,500,000. Since this contract was made, work in the quarry has been progressing steadily, although the unexpectedly large percentage of material that had to be rejected resulted in low yardages delivered to the dam.

The high percentage of reject in the quarry rock is the primary cause of the present difficulty at dam No. 1. The fact is that eighteen months after the work started only about 400,000 cu.yd. of material had been placed in a dam to contain 5,600,000 cu.yd., which was to be completed in 5½ years. The small percentage of material in the dam does not indicate inaction in quarry operations. Up to Oct. 1, 1934, approximately 3,400,000 cu.yd. of material, including stripping and waste, or the equivalent of about two-thirds of the total volume of the dam, had been removed from the quarry. In other words, little more than one-tenth the material moved from the quarry actually went into the dam.

PAY SCHEDULE AND QUANTITY ESTIMATES, DAM NO. 1

Classification	Price per Cu.Yd.	Estimated Quantity, (Cu.Yd.)	Actual Quantity (Approx.) to Oct. 1, 1934, (Cu.Yd.)
Dam excavation (all classes)	$0.24 to .80	1,817.000	1,132,900
Quarry stripping (measured in original position)	0.55	900,000	2,193,000*
Quarry waste (measured in dump)	0.40	1,800,000	1,140,600
Class A rock, in body of dam	0.75	4,100,000	73,600
Class B rock, in body of dam	0.40	643,000	301,300
Class C rock, on downstream face	1.20	470,000	8,800
Class D rock, packed in place on upstream face	2.45	349.000	0

*To Sept. 1. Payment for all material in the dam was to be based on yardage measured after dumping.

Contract Specifications on Rock—Under the terms of the contract the district pays at different rates for stripping, for waste material and for the several classes of quarried rock acceptable for use in the dam. The stipulated pay schedule and quantity estimates are given in the accompanying table.

Rock specifications, a highly important factor in the situation, require all rock accepted for use in the dam to weigh not less than 160 lb. per cu.ft. and to have a strength in compression of at least 5,000 lb. per sq.in. Class A rock was to constitute the bulk of the structure; class B rock was mainly for the dumped fill below original streambed level; class C was for the downstream face (12 to 20 ft. thick); and class D rock, specially selected for the upstream face, was to be packed in place. Size requirements were as follows:

A and B—40 per cent, to range in size from quarry chips up to 1,000 lb., 30 per cent from 1,000 to 3,000 lb., and 30 per cent from 3,000 to 14,000 lb., A and B were to be a "well graded mixture" with the greatest diameter of individual pieces not more than three times the least diameter.

C—selected angular pieces weighing 6,000 lb. or more, one-half of which must weigh more than 14,000 lb.

D—small rock up to a maximum of 10-ton size; 50 per cent to weigh more than 5 tons.

Before considering the analyses of the quarry situation made in recent reports, features of the construction work thus far will be presented.

Work at the present site was started March 15, 1933, on the 2,000-ft. tunnel driven through the left abutment, which was designed to serve as the diversion tunnel during construction and later as the main regulating outlet. Very little timbering was required in the tunnel, which traversed rock of good character having an average weight of 175 lb. per cu.ft. and an average strength of 12,000 lb. per sq.in. (tests on 3-in. cubes sawn from representative samples). The average use of explosives was 4 lb. per cu.yd. in the pioneer heading and 2½ lb. per yd. in the enlargement. In the pioneer heading the average round consisted of 27 drill holes about 11 ft. in length. The tunnel was lined with concrete that has a minimum thickness of 2 ft. and contains 57.3 lb. of reinforcing steel per cubic yard of lining. The diameter of the tunnel inside the lining is 30 ft.: its capacity is rated at 17,500 sec.-ft. under a 10-ft. head. The cost of the tunnel, including lining, was $380 per foot.

Abutments and Streambed—The east abutment, consisting of a wall of rock having an average slope of 6/10 to 1, was stripped with a hydraulic giant under a maximum pressure of 200 lb. per sq.in., using a 2½-in. nozzle. The face was trimmed as specifications required.

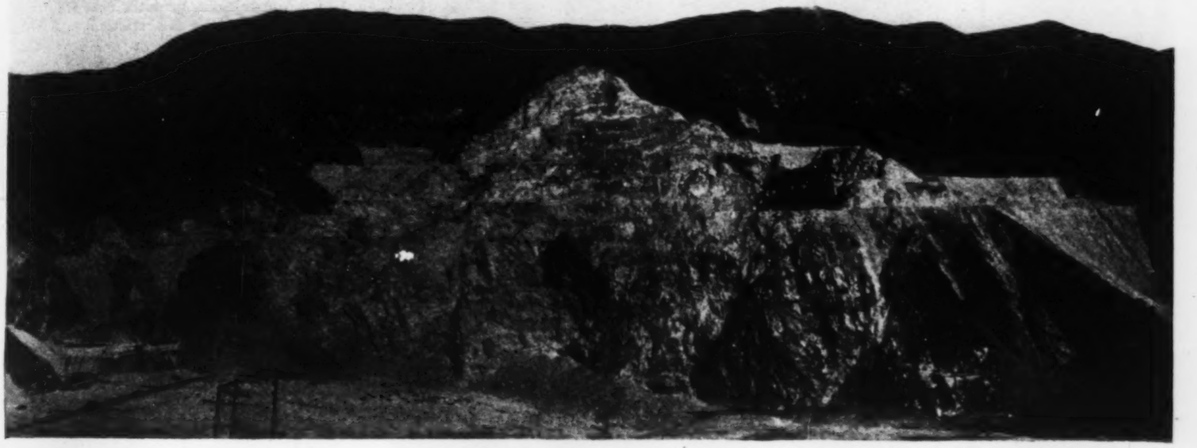

FIG. 3—FACE OF QUARRY NO. 10, indicating the extent of stripping operations, with the waste dumps in side canyons at both left and right. The downstream portal structure of the diversion tunnel shows at the extreme left.

Overburden was estimated to total 125,000 cu.yd. On the west abutment the loose overburden was removed by shovel and trucks, hauled upstream and used to blanket the hillside below the proposed spillway cut, which will be through the west or right abutment. Benching on the west abutment was extensive. On the west abutment the overburden removed totaled 235,000 cu.yd. Contract prices for overburden were 80c. per cubic yard on the east abutment and 48c. on the west.

In the streambed the removal of sand, gravel and boulders from the site was carried on with 4-cu.yd. electric shovels loading into 10- and 20-cu.yd. dump trucks, a fleet of 40 being maintained. The material was hauled an average of 1,000 ft. upstream from the dam site, and much of it was used in the diversion dam across the main streambed just below the entrance to the diversion tunnel. Material removed from the streambed was estimated to total 1,292,000 cu.yd. After the streambed stripping was finished, a cutoff trench was excavated and a concrete toewall poured.

The quarry selected as the source of material for this dam is the site known as No. 10; it is located ½ mile downstream from the axis of the dam and consists of a mountain spur roughly triangular in elevation rising steeply from streambed level. For the first 350 ft. of rise from streambed the face is sheer, and thereafter the slope is about 1 to 1 to an elevation some 600 ft. above streambed.

The quarry has been worked from a series of benches that are connected by roadways. Near the edges of the benches vertical holes 6 to 8 in. in diameter and about 50 ft. deep are put down, loaded with black powder and shot prior to attack of the quarry face by power shovels working on the next bench below. The average haul from quarry to dam is about 2,000 ft. and has been made largely with a fleet of twenty trucks of capacities ranging from 12 to 20 cu.yd. Rejected material has been dumped in ravines downstream from the quarry, but the available dumping space has been nearly all used up and the presence of dumps standing on steep slopes has been protested by Pasadena, whose reservoir storage would be depleted by extensive erosion and slumping of these slopes in wet weather. Some 2,200,000 cu.yd. were stripped from the quarry before hauling to the dam started.

As the months of 1934 passed and the material in quarry 10 got no better, the question of a change in policy was studied. Consideration was given to the development of other quarries. Either it would be necessary to change to some other quarry or to revise specifications for the dam. In August, 1934, E. C. Eaton, for seven years chief engineer of the flood-control district, resigned; soon afterward Samuel M. Fisher, a member of the district's engineering staff for several years, was appointed to succeed him. Prior to Mr. Fisher's appointment a new board of consulting engineers, consisting of R. J. Reed, L. F. Harza and

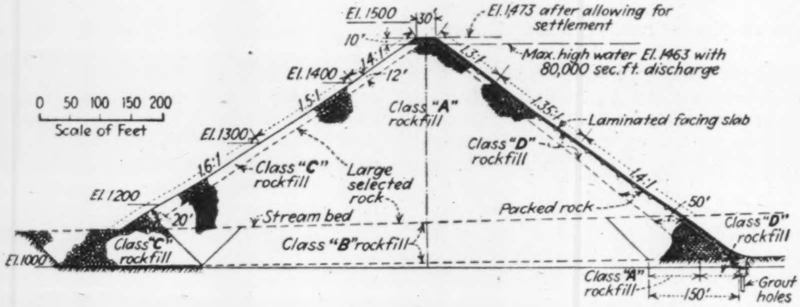

FIG. 4—SECTION of San Gabriel Dam No. 1 as specified in the contract.

I. C. Steele, who had been employed by the district previously in connection with investigation of settlement of dam No. 2, were requested to make a report also on dam No. 1. The report of this board (on dam No. 1) was made public simultaneously with the report of another board appointed under the previous engineering régime to review conditions at dam No. 1. This earlier board consisted of G. A. Elliott, Louis C. Hill, Rush T. Sill and C. F. Tolman; the first two are engineers; the two latter are geologists. Summaries of the recommendations of the two boards follow:

Elliott-Hill-Sill-Tolman Report on Dam No. 1—The report of this board, dated Sept. 17, 1934, refers to recommendations made some two months earlier calling attention to the unsatisfactory condition of the rock in the lower 25 ft. of the dam together with suggestions for improving the fill and a warning that the cost of the completed dam would exceed original estimates. On the present basis of the amount of waste necessary to obtaining rock suitable for the dam, the cost of each yard of rock in the structure is $1.90, this report states. At this rate the total cost of the completed dam and appurtenances would be in the neighborhood of $16,000,000.

To avoid this excessive cost, investigation should be made of less costly construction. Two general methods were suggested: (1) continue the dam as planned, using rock from the next cheapest source to quary 10; (2) change the type of dam to a combination rock and earthfill, using quarry 10 and as much of the stripping and waste materials already excavated as are suitable for the purpose.

Even if quarry 10 henceforward produces a greater proportion of rock to waste, a considerable volume of rock from some other source would be necessary; two such sources are (1) the streambed below the dam and (2) Bichota, about 8 miles from the dam. Both these locations should be explored thoroughly before any decision is made. At the same time the lower levels of quarry 10 should be explored with tunnels. If it develops that a recovery of as much as 36 per cent instead of the present 26 per cent could be expected later from quarry 10, cost for further work with quarry 10 rock probably would compare very favorably with the next cheapest source of rockfill.

An earth-and-rock-embankment type of dam with the downstream section built of rock having an outside slope of 2 to 1, the remainder composed of stripping and waste with upstream slopes of 3 to 1 and 4 to 1 would contain roughly 11,750,000 yd. Although spillway excavation and existing waste and stripping dumps would provide a part of this necessary volume, other sources than quarry 10 would be required. This type of structure, although of unprecedented height, could be made safe. The present cutoff and concrete face embedded in the dam would prevent leakage and permit the use of more porous materials than are used where the embankment itself is watertight.

No matter what source of fill material is used in either a rockfill or embankment type of dam, the final cost of San Gabriel Dam No. 1 probably will lie between $13,000,000 and $15,000,000.

PARTIAL ENGINEERING NEWS-RECORD BIBLIOGRAPHY ON THE MAIN FLOOD-CONTROL DAM OF THE SAN GABRIEL RIVER

Year	Vol.	Page	Subject of Article
1915	II	204	*$16,000,000 for Los Angeles County Flood Protection—I (*Eng. Rec.*)
1915	II	232	Same—Part II (*Eng. Rec.*)
1924	I	1088	*Water Conservation for L. A. County
1926	I	890	*Flood-Control Controversy in County
1927	I	579	*Board Reports on L.A. Flood Control Projects
1927	II	157	Contract-Award (Dam No. 1) Injunction
1927	II	239	Bids Rejected in Favor of Lighter Dam
1927	II	563	High Dam Planned in San Gabriel Canyon
1928	I	493	Suit Decides Height of San Gabriel Dam No. 1
1928	II	733	*San Gabriel Dam in Immed. Prospect
1928	II	784	Six Firms Bid on San Gabriel Dam No. 1
1929	I	1030	Construction Camp and Program for Dam No. 1
1929	II	509	Earth Slip at West Abutment of Dam No. 1
1929	II	667	Dam Site Declared Unsafe by Board
1929	II	699	*Serious Defects in Foundation Rock
1929	II	825	Board Investigates Safety of Dam Site
1929	II	895	*State Denies Permission to Build Dam
1929	II	944	San Gab. Dam Contract Cancelled
1930	II	783	Exploration Work Starts on New Dam Site
1931	II	900	Plans for New San Gabriel Dam Blocked
1932	II	177	Lone Bid for Dam No. 1 at New Site Rejected
1932	II	239	New Bids Called for Dam No. 1
1932	II	390	Second Lot of Dam Bids Rejected
1932	II	482	San Gabriel Dam Bids to be More Detailed
1932	II	794	West Slope Construction Co. Low Bidder at $8,600,527
1933	II	455	Preliminary Work Progressing at Dam No. 1
1934	II	510	Reports of Two Consulting Boards
1934	II	541	Temporary Suspension of Work at No. 1 Asked.

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*Comprehensive or specially significant articles during early history

In conclusion the board recommends the following three steps of procedure:

1. Thoroughly explore (*a*) quarry 10, (*b*) the streambed below the dam, (*c*) Bichota.

2. Make a plan along lines indicated above of a combined rock and earthfill dam.

3. Make careful cost estimates of completing dam No. 1 as a rockfill using various combinations presented under 1. above. Make a similar estimate of the dam described under 2.

The board also recommended temporarily ceasing work on the dam pending additional estimates if a satisfactory arrangement could be made with the contractor about a temporary shutdown.

Harza-Reed-Steele Report on Dam No. 1—Under date of Oct. 8, 1934, the Harza-Reed-Steele board reviewed the present situation at dam No. 1 and pointed out that under existing specifications quarry 10 could be expected to produce, altogether, less than one-third the required amount of rock. Moreover, the disposal of further quarry waste under the present plan of operation would be a serious problem.

The cost of bringing rock from Devil's Canyon (the quarry used for dam No. 2) or from quarries entirely outside the San Gabriel Canyon was rated as prohibitive. Other possible quarries which never have been adequately explored are Bichota Canyon and the Narrows. The nearest of these quarry sites, if found satisfactory, would add at least $5,000,000 to the contemplated cost of the dam, and opening the quarry would entail a delay of perhaps six months.

However, by a redesign of the dam section and an appropriate distribution in the body of the dam of the various classes of material found in the waste piles and in quarry 10, practically none of the available material need be wasted. Such a dam, with material properly graded, distributed and controlled, would be a better dam than could have been built with rock conforming strictly to the present specifications. This board, therefore, proposed:

1. Recovery of materials thus far wasted from quarry 10 and their use together with material from the spillway cut in the upstream portions of the dam.

2. Use of sound screened rock from quarry 10 and from the spillway cut graded from front to back to build a body of maximum porosity at the toe with an erosion-resisting blanket covering the entire downstream slope and elimination of the use of class C rock.

3. Building the main body of the dam of quarry-run rock from quarry 10 and from the spillway.

4. Flattening the slope of the upstream face and its concrete surfacing to about 1½ to 1, and modifying the packed rock or equivalent section to provide a more stable angle of repose for the fine material behind the face structure

5. Increase in downstream slope to 2½ to 1, to give additional stability to the dam by increasing its weight.

6. Continuation of sluicing for settlement of the fill if, as and when it produces results commensurate with its cost and the benefits obtained, together with investigation of the possible advantage to be gained in lieu of sluicing by compacting certain portions of the fill by rolling.

7. Increase in spillway capacity from 80,000 to 110,000 cu.ft. per second (with a freeboard of 5 ft.), to provide free discharge for as great a flood as has been known to occur anywhere on a drainage basin of equal area.

These major recommendations, with a few others of minor character, could be carried out, it was believed, by amending the specifications under which the existing contract is operated, without any change of contractor or extensive delay in operation.

The changes proposed by this board were believed to include features such as the use of spillway excavation, elimination of class C rock, etc., which would more than compensate for the increased yardage resulting from the flatter slopes recommended. In view of the fact that the only alternate procedure calls for the bringing in of rock from distant sources, the economies resulting from the plan recommended, it was pointed out, would result in savings of at least $5,000,000.

Present Status of Dam No. 1—On the basis of the two reports abstracted in the foregoing, the board of supervisors held conferences with the contractor, and on Nov. 13 ordered the contractor to suspend work for four months. During this interim it is hoped that the plans and specifications for the dam can be modified so that (*1*) the revised plan will meet with the approval of the state engineer, and (*2*) the work can be completed within the funds which the district still has available for the work.

The modified plans and specifications are to be submitted both to the state engineer for approval and to the court to determine the legality of a modified contract.

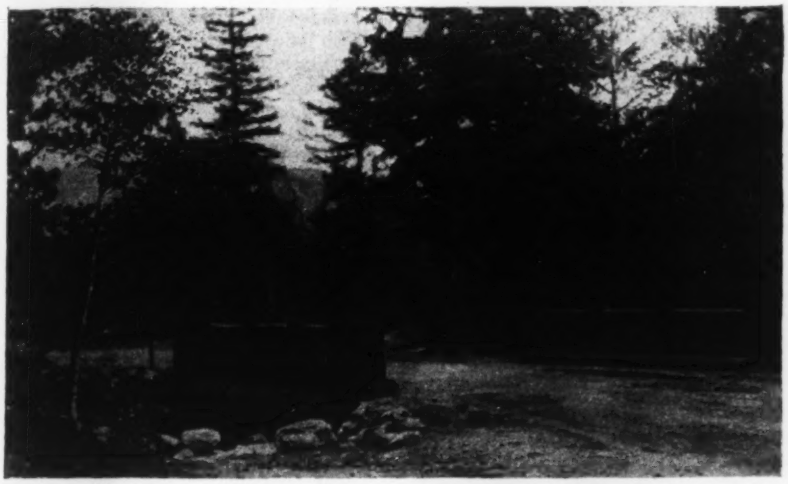
During the idle period an effort also is to be made to agree with the contractor on the amount of damages to be paid for the temporary cessation of work. If no agreement is reached, this too will be submitted to a court for adjudication.

Appended is a partial list of articles relative to flood-control district activities concerning work in San Gabriel Canyon, selected to include the more important ones and to indicate the trend of events. The titles indicate the prevalence of controversial issues and the difficulties in which the projects have found themselves right from the outset.

An outline of the situation at San Gabriel Dam No. 2 will follow in an early issue.

Some Design Notes on Small Log Bridges

By W. A. Burnham
Consulting Engineer, Boulder, Colo.



LOG BRIDGE in Rocky Mountain National Park, in Colorado, on a main transmountain highway illustrates use of large stringers and end posts.

SMALL LOG BRIDGES are being constructed in remarkably large numbers for mountain or forest roads and trails, and in many instances with unskilled labor and supervision. Therefore, a few remarks on structural and architectural features may prove helpful. From the structural viewpoint:

1. Conventional fiber stresses are usually too high to prevent unsightly sag after a few years. Logs are sapwood, and this type of timber suffers greater deformation than timber cut from nearer the heart. Also no initial camber can be given to a log. Fiber stresses should be reduced.

2. The usual fiber stresses often dictate the use of stringers of smaller section than is advisable for long life.

3. Conventional sizes and fabrication methods may allow unfortunate vibration frequencies. More and larger stringers are usually the answer. For a favorable impression of comfort and security, the natural frequency of vibration should be kept out of the range of 2 to 7 vibrations per second—particularly for the larger live loads and corresponding larger amplitudes.

From the architectural viewpoint:

1. Avoid the flat-roofed cowshed effect produced when flooring projects on each side.

2. Avoid the country fence effect, produced when a railing member is placed near or at the top of the posts.

3. Do not cut the bridge in two by a post at the center of the span. The architectural effect is as disastrous as that of the two-span arch.

4. Avoid the stockade effect produced by too many posts.

5. Diagonal parts in railing construction are difficult to reconcile with log bridge lines.

6. Do not camouflage or partly cover the outside stringers. They are the apparent foundations of the structure. Small outside stringers tend to give a top-heavy appearance to the whole structure. Large outside stringers with large interior stringers usually prevent unpleasant vibration. Or with smaller interior stringers, the combination can easily be arranged to dampen vibrations effectively. Furthermore, if the outside stringers are large, but not allowed to project well out from the center of the posts, much of their architectural effect is lost because they appear to be cut into short pieces by the bottoms of the posts.

7. Do not spoil a log bridge with paint or dark stain. The natural fresh beauty of many woods can be perpetuated by applying boiling hot paraffin on the visible surfaces. Spar varnish and some cheaper materials of the trade are colorless preservatives whose permanence is fairly good.

8. Posts that are much smaller than the outside stringers can spoil a good bridge. The four end posts particularly should be large. All posts should be less than 3 ft. high above the top of the floor.

9. The rails must furnish the contrast and therefore should be narrow. Two seem appropriate and should never be near the center line of the posts nor flush with the sides of posts.

10. Substantial wheel guard logs, of slightly more than quarter-round section, should be arranged on top of the flooring boards or logs, to prevent chattering under heavy passing loads. The fasteners should be such as to make these guards serve also as vibration dampeners. These guard timbers should be gently beveled at each end, and should never project beyond the center of the end posts.

Concrete Experimental Work Under Desert Conditions

Extensive laboratory and field investigations are helping to determine the relative merit of various concrete combinations for the Colorado River Aqueduct

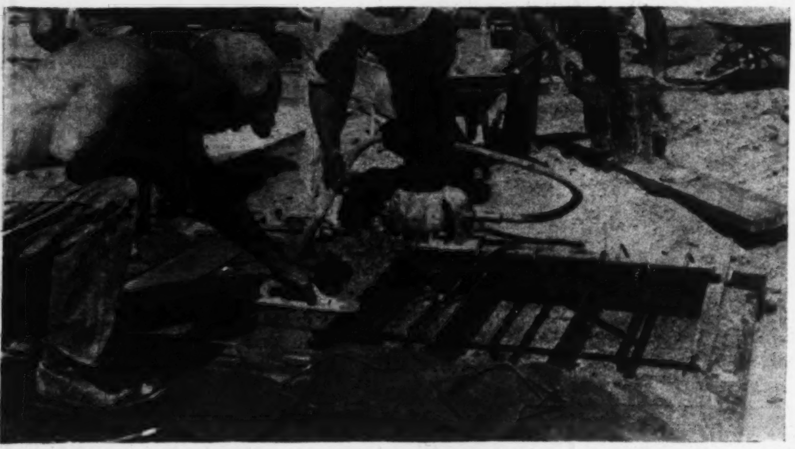


FIG. 1—PLACING CONCRETE in field-test slabs. In this set of slabs a small electric vibrator is used.

WHAT KIND of concrete can best withstand the severe conditions obtaining along the Colorado River Aqueduct? How can such concrete be obtained for the least money? These are questions which the Metropolitan Water District of Southern California is studying in a series of practical experiments under careful supervision.

The District's laboratory at Banning, equipped to do the extensive testing incidental to the aqueduct construction, is responsible also for experimental work in the field. Questions as to ingredients and proportions of concrete, methods of curing, use of different sealing compounds, and relative values of different colors for covering the completed structures, are among the subjects under study by the Banning laboratory staff.

The following outline of the work under way is intended to indicate the nature of the investigations. In most of the cases cited, no definite results can yet be given, as the tests are still incomplete.

Slabs exposed to weather

One of the most comprehensive studies undertaken has to do with the effect of desert weather on concrete of various mixes, cement compositions and curing procedures. For tests of this sort it was decided to use concrete slabs 6 in. thick with surface dimensions of 1x3 ft. These slabs were large enough to give practical results and not too large for convenient handling; they weigh 225 lb. each. A ⅜-in. U-bar is embedded near the end of each slab for convenience in handling. Five hundred of these slabs were made, 200 for observation at the Banning laboratory and 300 to be laid out in an exposed location at the headquarters of Division 3, selected as a convenient typical desert location.

Some of these slabs will be tested to destruction after six months, some after one year. However, volume change and moisture content during this period of test and prior to the destruction of the specimens are expected to give most important information.

Of the 200 specimens under observation at Banning, 100 are kept moist at a temperature of 70 deg. F. (standard A.S.T.M. conditions) as "control" specimens for comparison. The second 100 at the Banning laboratory are divided into two groups of 50 each, one for studying the behavior of different cements and the other for comparing the effect of different curing procedures and condition of exposure—i.e., studies pertaining to concrete as distinct from cement. Each of these groups of 50 is given treatment which it is hoped will emphasize and magnify the effect of exposure under natural conditions on the desert but will give these effects at a more rapid rate. For this accelerated test the specimens are being wetted and dried alternately at temperatures of 20 and 160 deg. F., since wetting and drying occur at both temperature extremes. This temperature range of the exposed upper face of the slabs as cast is made to occur in 24 hours, as it would on the desert when changing from the temperature of the coldest night to that of the hottest summer day. Record is being made of volumetric changes in both vertical and horizontal planes. Strain meters, strain gages and resistance thermometers are placed in the top and bottom of the slabs.

The 50 slabs used for comparison of concrete *per se* are laid outdoors in the Banning laboratory yard, where they are exposed to the weather for eight months and are then subjected to the accelerated test for 100 cycles.

The 300 slabs that were left exposed to desert weather conditions at Division 3 headquarters were put in all at once in May, 1934. As in the case of the slabs at Banning, the Division 3 slabs are being subjected to frequent observation and measurement, these results to be compared with those of the control specimens at Banning. When the time comes for test to destruction the slabs will be tested as beams with the top or exposed surface in tension. After the beam test the broken parts are to be subjected to a sandblast to determine their relative resistance to attrition. Results of the sandblast test will be determined by differential weighing.

All of the 500 slabs were arranged in groups of five, alike for each variable. A pair of such groups or ten specimens (Fig. 2) constituted a unit. Five compositions of cement were included in the investigation, each ground to two degrees of fineness. Thus ten different cement specifications were used for information on comparative results. The cements used were specially prepared at the cement mill operated in connection with the testing laboratory of the University of California at Berkeley, Calif.

In casting the slabs various methods were used. Some concrete was hand placed, and some was vibrated (Fig. 1). The group as a whole was selected to give a range in results as closely as possible similar to those that would be encountered under construction conditions on the aqueduct.

Methods of curing

Where concrete is placed in work on the desert, considerable importance attaches to methods of protecting exposed surfaces from excessive evaporation. Various phases of the problem are met in the aqueduct work. On the Fan Hill siphon, for example, it was desired to keep the inside surface damp for 28 days in conduit or siphon sections whose outer surface was daily at a temperature of 125 deg. F. By hand-sprinkling methods it was found that one man could adequately handle a length of only about 600 ft. at early ages. For three shifts daily this meant that considerable labor would be required for sprinkling, the exact amount depending upon the rate of progress. Experiments, therefore, were made with humidity control, using several kinds of sprays, dividing the conduit into sections by means of canvas brattices or shiplap partitions.

Among the methods tried were: (1) sprinklers which sprayed water upward against the arch; (2) water and compressed-air jets mixed, with the jets in pairs pointed in opposite directions to develop air circulation; (3) a motor-driven disk with holes through which water was atomized; and (4) heating the curing water used inside the conduit sufficiently to get condensation on the inside of the walls. The most practical and effective method of keeping the surface continually damp proved to be a spray or sprinkler system that could be controlled by an automatic valve. The valve could be adjusted to turn the water on and off automatically, as might be required for results desired.

The major part of the curing experiments, however, has to do with the relative merits of sealing compounds. For this purpose 500 specimen cylinders, 6x12 in., were made up at different times. These specimens were taken from the forms and painted 24 hours after pouring; a second coat was put on in 48 hours. On the following day the specimens were delivered to Division 3 for desert exposure (Fig. 4). Weight determinations (to give a record of the amount of evaporation) were made before painting and daily thereafter for five weeks, after which the weights were taken every week for the remainder of three months. These records were compared with those from control specimens maintained in the laboratory at 11 per cent humidity, 100 deg. F. For these curing tests, twenty different sealing compounds were used.

Sulphate-resistant cement

West of the San Jacinto tunnel, where the aqueduct traverses the coastal plain, the groundwater occasionally contains sulphate. It is therefore desirable to have a concrete that will have high resistance to sulphate action. Various cements of known compositions were subjected to tests intended to reveal resistance to sulphate action.

Aggregate tests

For three years tests have been under way on materials taken from natural deposits along the aqueduct that would have to be used in making concrete, to determine the suitability of different materials and to define the degree of accuracy required in screening, in order to get better control of concrete quality.

More than 60 natural deposits of aggregate materials were located, and from them about 30,000 mortar and concrete specimens were made and variously tested. These specimens were subjected to strength tests, sodium sulphate tests, freezing and thawing tests and tests to determine volumetric

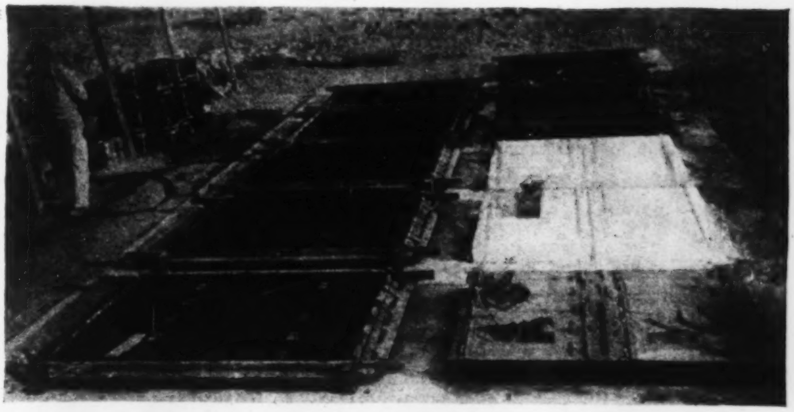


FIG. 2—CONCRETE TEST SLABS on the desert. At the left are 50 forms in groups of ten. On the right are completed slabs; different colors indicate different curing and temperature-control methods.

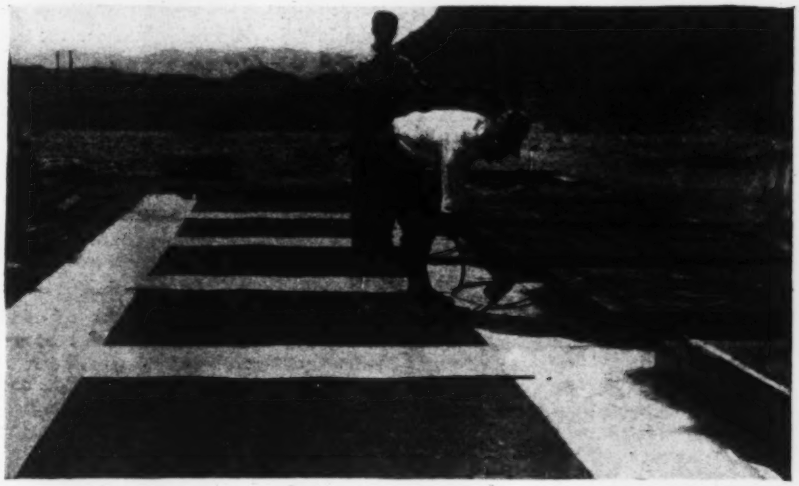


FIG. 3—SPRAYING SEALING COMPOUND on field-test slabs. The subgrade is first wet and rolled; galvanized metal is placed between the slabs, so that the subgrade will not dry out between them. Sealing compound is sprayed on the sides as well as at the top.

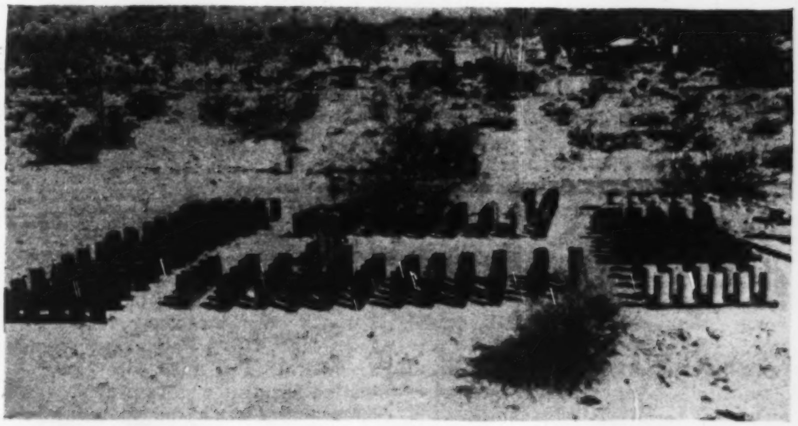


FIG. 4—TESTING SEALING COMPOUNDS on concrete cylinders. Successive weight differences will show the relative value of the compounds in retarding moisture loss.

change. Aggregates were tested for relative quality and durability by means of the rattler, sodium sulphate test, freezing and thawing, etc. On the whole, the available materials were found quite suitable; simple specifications sufficed to maintain results within the desired range.

Color tests

Although the advantages of light colors were appreciated before undertaking the work, it was thought advisable to make observations on white, black and natural color of concrete surfaces exposed to the sun's rays. The tests gave some interesting figures on the effect of dark surfaces to expansion and contraction. A black concrete surface on a hot day in the desert was found to produce a temperature in the concrete beneath it some 44 deg. F. higher than a white surface. As a result, where black sealing compounds are used, the specifications require the compound to be placed at night and to be followed by whitewash at sunrise on the following day.

Monolithic vs. precast pipe

The 12-ft. inside diameter of inverted siphons on the aqueduct is not in excess of the size of concrete pipe that can be precast and moved to place. Before the siphons on the aqueduct were contracted, the district built a siphon by the cast-in-place method (Fan Hill siphon), and a very similar siphon (Little Morongo) was contracted for construction of precast pipe. The Little Morongo siphon proved the feasibility of the precast pipe for this kind of construction, and thereafter on the siphons offered to contractors alternate bids were taken on both types.

F. E. Weymouth is chief engineer and general manager of the Metropolitan Water District of Southern California. The Banning laboratory, ordinarily employing a staff of about twelve men in office and field, is under the direction of Lewis H. Tuthill.

PWA Has Allotted $6,000,000 To Federal Mapping Agencies

THE Public Works Administration has made allotments aggregating $6,000,000 to various federal agencies for carrying forward mapping activities, including the inventorying of the natural resources of the country, and a further enlargement of the mapping program is now under consideration. The government offices engaged in this work include the Forest Service, Bureau of Air Commerce, Coast and Geodetic Survey, Soil Erosion Service, Geological Survey, and General Land Office.

A PWA allotment of $200,000 to the Soil Erosion Service is being used in making a map as an important feature of the soil-conservation program. A comprehensive chart of land and soil conditions is now nearing completion. This map will show the extent and degree of soil erosion, the degree of slope, the dominant soil types, and the land-use practices of every county of the country. Within the actual projects that have been established by the Erosion Service each individual farm is mapped on a scale of 500 ft. to the inch. Wherever groups of landowners set up erosion-control programs, these maps are intended to present a complete picture of their county and its soil conditions.

A record-size aerial mosaic-map is nearing completion under the direction of the Soil Erosion Service, consisting of more than 7,000 separate photographs covering 24,500 square miles of the Navajo reservation in Arizona and New Mexico. This area constitutes one of the outstanding projects of the Erosion Service in land rehabilitation and conservation.

The task of surveying and mapping planting areas in the national forests is being done by men employed by the Forest Service with PWA funds. Base maps have been prepared for areas aggregating 4,000,000 acres, and these maps will form the basis for charts showing the need for development and conservation of forest areas. From the maps new planting areas are selected.

On Sept. 6, 1933, the PWA made available to the Geological Survey $2,400,000 for topographic mapping and the accumulation of information on the surface-water resources in the public land states. Of this amount $35,000 was allotted for topographic surveys in Alaska, and $25,000 was allocated for the same work in Puerto Rico.

For about 125 years surveys have been in progress on the public domain under the supervision of the General Land Office. These surveys differ from those carried on by other governmental agencies because they form the basis for the acquisition of title to the public lands. This establishment of property boundaries is fundamental to many other activities of the government. Out of 2,000,000,000 acres of public lands, 500,000,000 acres remain unsurveyed, and of this area 375,000,000 acres are in Alaska. Survey work carried on during the past year by this agency under a PWA allotment of $1,000,000 has extended over eighteen states and provided employment for more than 1,000 persons.

To complete the series of airway maps being compiled by the Bureau of Air Commerce, $509,000 has been allotted by the PWA. These maps are intended to show beacon lights, airports and radio stations. Land elevations are clearly indicated. On a scale of eight miles to the inch, each map is printed on a 20x40-in. sheet and represents a strip of territory 325 miles from east to west by 150 miles north to south. The complete series of 87 airway maps will be finished in about eighteen months.

An allotment from the PWA is enabling the Coast and Geodetic Survey to carry forward important work in modernizing its charts. The work includes: (1) surveys of intra-coastal waterways, correcting errors in charts, many of which have not been revised since the Civil War; (2) surveys of ports and harbors along the Pacific and Atlantic coasts and revision of anchorage charts; (3) offshore hydrographic surveys of the continental shelf, using echo soundings for determining depths.

Almost all of the PWA funds that have been used for this mapping work have been paid out in salaries to previously unemployed men, most of whom are engineers or technicians who had previous training in this type of work.

Real-Property Surveys of St. Paul and Minneapolis

The CWA real-property survey made last winter in St. Paul and Minneapolis revealed the essential differences in the Twin Cities. The survey was made on dwellings, exclusive of hotels, clubs, rooming houses and summer cottages. Enumeration was also made of sanitary facilities, rents paid, property values and distribution of families in living quarters. In St. Paul 65,174 dwellings were enumerated and in Minneapolis 95,859. Respectively, materials used were 19 and 35 per cent stucco, 72 and 58 per cent frame, 5 and 4 per cent brick. In the nineteen years following 1909, 51 and 57 per cent of the buildings were erected. Since then only 3,000 and 6,602 buildings have been built, indicating that little building has taken place in the last five years. Minor repairs are needed by 43 and 39 per cent, and structural repairs are needed by 15 and 12 per cent. Structures no longer fit for habitation and ready for demolition number 1,133 and 1,323, respectively. In St. Paul there are 5,063 vacancies and 7,491 families are doubled up. In Minneapolis the comparative figures are 11,952 vacancies and 6,928 families living with other families.

Bituminized Concrete Casing for Piles in Sea Water

Precast concrete piles for trestle across swift tidal waters of Bellamy River in New Hampshire encased for height of tide range with precast asphalt-impregnated concrete plates embedded in pile

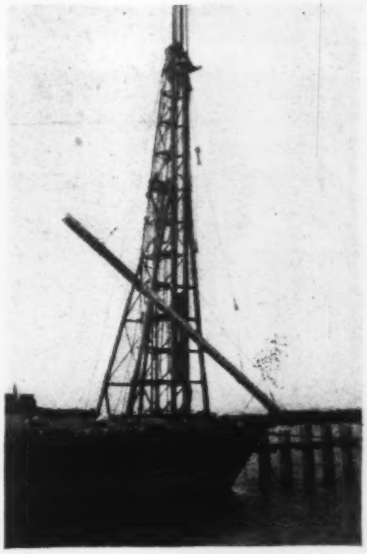


FIG. 1—PILEDRIVER handling 105-ft., 20-in.-square, reinforced-concrete piles for the Bellamy River road bridge.

EXCEPTIONALLY LARGE precast concrete piles, having the unusual feature of slabs of asphalt-impregnated concrete cast peripherally into the pile for that part of its length affected by the rise and fall of the tidal waters, are being used in constructing the Bellamy River Bridge in New Hampshire. This bridge gives access from the west to the new road route to Portsmouth over the Little Bay Bridge described in *Engineering News-Record*, Sept. 27, 1934, p. 387. It is a pile trestle 660 ft. long between the ends of two embankments extending outshore from the two banks of the river. At about mid-length of the trestle structure is a steel-girder bascule span 49 ft. long from trunnion to end bearing.

Pile structure

The structural interest of the Bellamy River Bridge lies principally in the concrete trestle. The steel span is a simple counterweight bascule on a granite-faced concrete pier on timber piles. As shown by Figs. 2 and 3, the trestle is of exceptionally sturdy design. The twenty spans of deck are carried on bents of five 20-in.-square, reinforced-concrete piles ranging in lengths from 70 to 105 ft., these lengths determined by borings made by the contractor. The piles are driven vertically except for the bents under expansion joints and those forming the rest pier for the bascule span. At these three points alternate piles have opposite batters as indicated on the drawings (Figs. 2 and 3).

The deck structure, including the caps for the pile bents, requires little explanation aside from the drawings. The generally heavy reinforcement is observable. The expansion joint is a detail of interest and also the very rigid across-deck reinforcing trusses for the deck slab. The wearing course of this slab is a different and richer mixture than that of the reinforced part of the slab, but it was laid closely following and before initial set had taken place in the base course.

In specifying the concrete for the trestle structure a rather unusual variety of mixtures was required, as shown by the accompanying table. A variation of 15 per cent in the ratio of fine and coarse aggregate was allowed to secure workability. Placing and formwork followed usual good practice, but all concrete was required to be compacted by vibrators giving a minimum of 3,000 vibrations a minute.

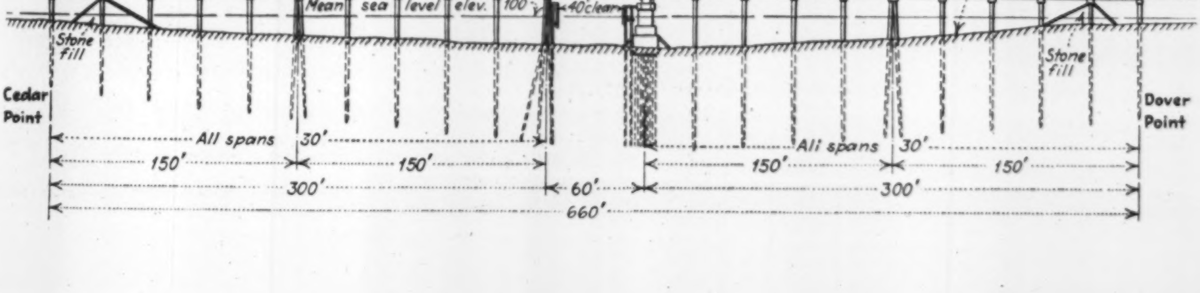
Casting armored piles

The piles for the trestle, as shown by Fig. 3, were 20 in. square, with chamfered corners, reinforced by eight longitudinal bars and a spiral hoop. The section (Fig. 3) is through the armored part of the pile, but the unarmored part had the same dimensions. No armoring was used on the piles for the shore bents; all others were armored for a length of 18 ft. in the zone of tide movement. All piles were tapered for 6 ft. at the bottom to a 10-in. square point.

The piles were cast on a false deck on a scow in fourteen parallel forms. Concrete was mixed on an adjacent scow and wheeled to the forms in buggies. About the only unusual detail of casting was the placing of the asphalt-impregnated concrete casing. This consisted of a peripheral covering of eight precast slabs 3 ft. long recessed on the inside to bond with the pile concrete. The slabs were cast and impregnated at the Cambridge, Mass., plant of the contractor and from there trucked to the job. Casting and penetration followed substantially the procedure described previously (*ENR*, Jan. 26, 1933, p. 108).

On the casting scow, six face slabs were first roughly lined up on the bottom board of the form. Then, a slab at a time, they were butted together in exact line, and the butting joints were filled by pouring with a hot asphalt compound. Each joint was poured as it was made, the asphalt becoming firm in about 5 min. The corner slabs, a row on each side, were then placed and the joints sealed. The layout then was as shown by Fig. 4. The reinforcing unit was next placed, the pile form sides were erected and yoked together across the top, and the reinforcing unit was suspended from the yokes. The side face slabs were then jointed and sealed to the lower corner slabs, and finally the upper corner slabs were jointed and sealed to the side face slabs. The

FIG. 2—ELEVATION of Bellamy River Bridge, showing main structural elements and dimensions.



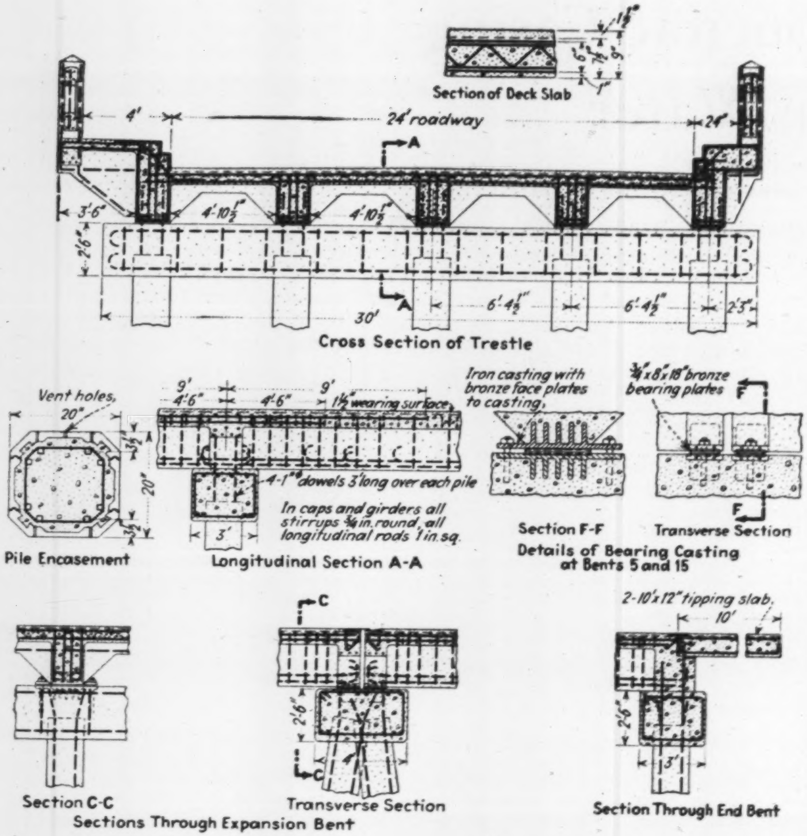

Section of Deck Slab
1½"
6½"
7½"
9"
1"
4'
24' roadway
24"
A
3'-6"
4'-10½"
4'-10½"
2'-6"
A
30'
6'-4½"
6'-4½"
2'-3"
Cross Section of Trestle
Vent holes,
20"
3½"
20"
3½"
Pile Encasement
9'
4'-6"
4'-6"
9'
1½" wearing surface,
4-1"ᵠ dowels 3' long over each pile
In caps and girders all stirrups ¾ in. round, all longitudinal rods 1 in. sq.
3'
Longitudinal Section A-A
Iron casting with bronze face plates to casting,
¾"x8"x18" bronze bearing plates
F
F
Section F-F
Transverse Section
Details of Bearing Casting at Bents 5 and 15
C
C
2'-6"
Section C-C
Transverse Section
Sections Through Expansion Bent
2-10'x12" tipping slab,
10'
2'-6"
3'
Section Through End Bent

FIG. 4—SETTING IMPREGNATED-CONCRETE SLABS in place for bottom and Bridge in New Hampshire.

set-up at this time was as indicated by Fig. 5, which is a view posed for the purpose.

The pile was concreted beginning at one end and working toward the other, and as pouring proceeded an internal vibrator (Fig. 6) was used to settle the concrete into the form and around the reinforcement. There was of course no top form, this face of the pile being finished by floating. At the armored part of the pile the concrete was poured and vibrated inside the slab casing as it was inside the forms at the parts not encased. With the casing filled, the top slab was placed and all voids underneath were mortar-grouted through holes in the slab as shown by Fig. 7. The slab joints were then sealed with a hot asphalt compound.

By using four buggies, about one pile an hour was poured. The specification required fourteen days' curing before driving. Using the rich mixture (indicated in the table) of high-early strength cement, the forms were stripped on the second or third day after casting. Before and after for a total of ten days the piles were covered with wet burlap soaked down every day by hose. For the last few days the piles were air cured.

Piledriving equipment

The lengths and weights of the piles called for piledriving equipment of exceptional capacity, and a contract for driving was let to the Raymond Concrete Pile Co., of New York, which placed its largest driver on the work. This machine is shown by Fig. 1. The driver, with 92-ft. leads, is mounted on a steel scow 85x32x7 ft. It has a twelve-drum hoisting engine, six of the drums handling maneuvering lines. Two 75-hp. and one 90-hp. oil-burning boilers supply steam to the hoist and to two jet pumps, each of 1,100-gal. capacity per minute. The pile-handling capacity is 50 tons. On the Bellamy River Bridge it handled 105-ft. piles weighing 22 tons.

The driver has two lifting lines, each with its individual drum. These lines pass over individual sheaves at the top of the leads and down to a set of blocks, as indicated by the sketch Fig. 8. Each block carries a suspended sheave. Through the sheave on the left-hand line *A* facing the driver, an equalizing cable *a a* runs to slings around the pile at the butt end. On cable *B* an equalizing cable *b b* carries two sheaves through which secondary equalizing cables *c c* pass to four slings around

FIG. 4—SETTING IMPREGNATED-CONCRETE SLABS in place for bottom and lower corners of piles. Note the recesses for bonding to pile concrete.

FIG. 5—COMPLETE casing slab set-up for placing pile concrete.

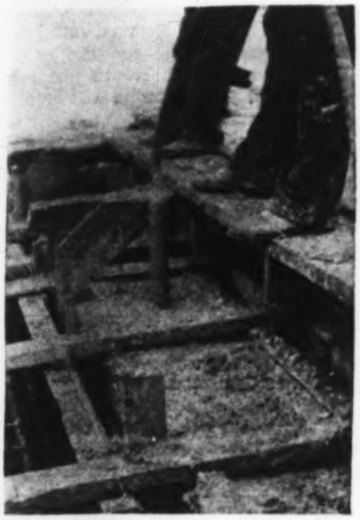


FIG. 6—INTERNAL VIBRATOR compacting concrete in pile for Bellamy River Bridge.

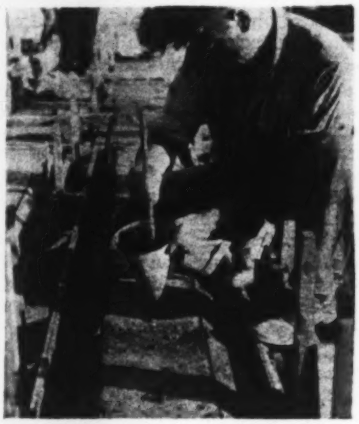


FIG. 7—GROUTING top casing slab in place on top of pile concrete.

the pile. By this arrangement the lifting strain is applied to the pile at six equidistant points and is equalized for any postion of the pile.

Driving the piles

The alignment and spacing of the piles were determined from shore sights. The driver was maneuvered by its anchor lines until its leads were exactly over location. A vertical jet was then worked down to loosen the ground well below the riverbed. The driver was then moved over to the casting barge to pick up a pile and then moved back to location to up-end and drive the pile. The view (Fig. 1) shows a pile being picked up and swung into the leads.

Each equalizing cable had a wire-rope loop sling at each end, one end of each sling being clamped permanently to the equalizing cable and the other end shackled to it after passing around the pile. By pulling evenly on the two lift lines *A* and *B* (Fig. 8) the pile was lifted in horizontal position and so carried to where it was to be driven. In lifting the pile the slings had necessarily to be passed under the bottom board of the form, and at sling locations this board had a narrow panel that could be picked up and carried away by the sling, leaving the remainder of the form intact in place.

The pile in process of being up-ended is shown by Fig. 1. This was done by lifting on line *A*, Fig. 8, and holding steady on line *B* until the pile hung vertical. The lower slings were then unshackled, and the pile was slipped in between the leads. At deck level a pair of guides operated by a separate engine was run out to clasp the pile and hold it plumb.

Driving began with the slings of line *A* still holding. The 10-ton hammer was then lowered onto the pile, and line *A* was slacked off until the pile had sunk by gravity as far as it would. The hammer was then put in operation acting on a cushion of laminated wood set on the top of the pile. In driving the batter piles all operations were the same except that the leads were canted to the proper angle. The jets were used as the ground conditions required.

In general, the holding ground for the piles was excellent; except for a shallow top of silt, it was composed of layers of sand and gravel with occasional clay. Driving in this ground required only normal procedure, and all piles were put down to assigned depths. All problems in driving centered in the pile weights and lengths to be handled, which required exceptionally large equipment.

Bituminized casing

As a design practice the casing used on the piles has creditable precedents. Concrete piles impregnated with asphalt have been in service in Los Angeles Harbor, Calif., for more than ten years and at the Naval Fuel Depot, Melville, R. I., since June, 1924. They remain in excellent condition. Articles on the impregnation of concrete piles with asphalt have been published in *Engineering News-Record*, Dec. 16, 1926, p. 999; July 18, 1929, p. 95; the use of asphalt-impregnated concrete slabs for lining a salt-water intake for a power plant at Seal Beach, Calif., was described Jan. 26, 1933, p. 108.

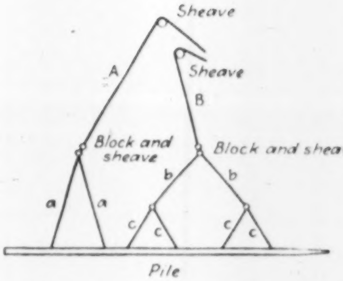


FIG. 8—SLING ARRANGEMENT for lifting and up-ending 105-ft., 20-in.-square, reinforced-concrete piles.

Less expensive procedure

In the pile protection formerly undertaken the whole pile was impregnated. This calls for a plant beyond the means of any but large operations, and bituminized concrete casing slabs were developed to simplify the protection procedure and reduce cost by limiting the protection to the parts of the pile needing it. At Bellamy River, for example, the 18-ft. casing zone covers the 6-ft. tide range with ample safety zones above and below. The protective action of the asphalt is that it seals the pores of the concrete and keeps out disintegrating sea-water salts and frost action. These destructive forces are most severe from low-tide line to several feet above high tide. Wave and tide action, together with the alternate wetting and drying, continually change the moisture content in the interstices

CONCRETE MIXTURES FOR DIFFERENT PARTS OF BELLAMY RIVER BRIDGE

	Water, Gal. Per Sack	Proportions			Max. Size Agg., In.	Slump In.
		Cement	Sand	Coarse		
Concrete piles	4¾	1	1½	2½	1	2
Trestle deck	5¾	1	2	3½	1½	3
Drawspan pier and counterweight	6	1	2½	4	3	4
Roadway wearing surface	5½	1	2	1½	½	3
Precast railing and lamp posts	5¾	1	2½	3	¾	2
Precast pile encasement	4	1	3⅜	1⅝	⅜	2

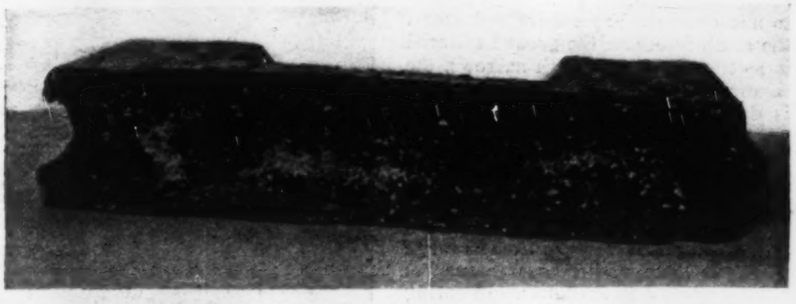


FIG. 9—PENETRATION of asphalt into concrete of casing slab shown by cross fracture.

of the concrete and aid disintegration. The concentration of salts tends to carry the weathering deeper.

Direction

The Bellamy River Bridge was undertaken under a PWA loan and grant to the New Hampshire Toll Bridge Commission as a part of the main-road improvement, including the Little Bay Bridge (*ENR*, Sept. 27, 1934). Fay, Spofford & Thorndike, Boston, Mass., were the engineers, and the Warren Brothers Roads Co., Cambridge, Mass., were the general contractors at a bid price of $236,145. The Raymond Concrete Pile Co., New York, had the subcontract for driving the piles. The roadwork was carried out by the New Hampshire highway department, Frederick E. Everett, commissioner, and D. H. Dickinson, chief engineer.

Maintaining Vancouver's Submerged Pipe Lines

Experiences with the maintenance of a number of supply mains bringing water to the city from across Burrard Inlet—Problem of salvaging the lines crossing the First Narrows when new water tunnel was put into operation

By W. H. Powell
Chief Engineer,
Greater Vancouver Water District

The Water Supply of Vancouver, B. C., is derived from two watersheds situated to the north of Burrard Inlet, a deep tidal arm of the Pacific, while the city is situated to the south of it. To bring the water from these drainage areas to the city, it has always been necessary to cross this body of water, and until recently all these crossings have been made by submerged pipe lines at the two "narrows" points. Last year the Greater Vancouver Water District put into service a new concrete tunnel at the First Narrows and undertook the salvage of the pipe lines at that point. The following article recounts the District's experiences in maintaining these pipe-line crossings and the salvaging of those at the First Narrows. —Editor.

Since 1889 the city of Vancouver, B. C., has at various times placed submerged pipe lines across Burrard Inlet at the First and Second Narrows until in July, 1931, there were in operation altogether two 12-in. and four 18-in. pipes across the First Narrows and ten 18-in. pipes across the Second Narrows. In general, the submerged pipes are from 1,800 to 2,500 ft. long from their connection with a supply main on the north shore to their downstream connection on the south shore. The foreshore on the north of both narrows is sand and gravel, which extends almost to mid-channel. From there and across the south foreshore the ground material is soft sandstone. In both narrows, the sandstone portion has many bluffs and is strewn with large boulders, some of which are 12 to 15 ft. in height and even more in length and breadth (*ENR*, Sept. 2, 1926, p. 366).

At low tide the greatest water depth at the First Narrows is about 48 ft. and at the Second Narrows 78 ft. The range of tide is 16 ft., and the current reaches a velocity of 7 to 7.5 knots. In spring the slack-water period is very short.

The total pipe capacity across the inlet was made in excess of the capacity of the connecting supply pipes, so that if one or more of them should happen to be out of commission at the time of the maximum demand, the quantity of water available would still be sufficient. That this was not an over-caution was proved in April, 1924, when two of the five pipes in the First Narrows and three of those in the Second Narrows were damaged at the same time. Again, in August, 1925, three of the six in the First Narrows were broken in one disaster, while at the same time one of the six in the Second Narrows was out of commission.

There were many causes of breaks in the pipes, some of which were as follows:

1. Being struck by ships or ships' anchors. This has occurred on sixteen different occasions since 1894. Once, due to divers' incompetence and other reasons, nearly six months was required to effect repairs.

2. Settlement of the pipe where it went over boulders or ledges. Immediately after a pipe was pulled into position a diver was sent over it to note and correct such places, and they were then built up with sacks of sand, gravel and plenty of cement. Notwithstanding this precaution and frequent inspection, many of the pipes were damaged by settlement.

3. Settlement, due to the washing by the tidal current of the sand and gravel from under the pipe.

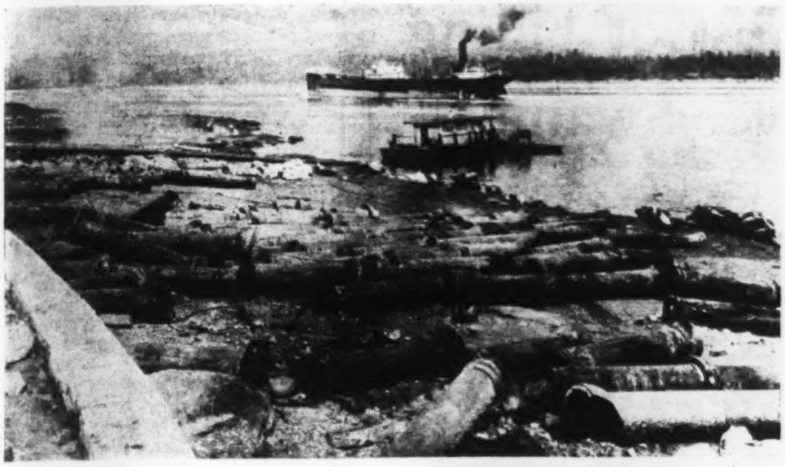
4. A small leak at a lead joint, which under a pressure of 150 to 275 lb. caused the surrounding sand to abrade the cast iron and to wear so thin that it cracked. In recent years a protection against this abrasion was devised by cutting old steel pipe in half longitudinally, and placing it over the operating pipe, digging down its edges into the sand sufficiently to cause the sand to move over the top. The steel pipe afforded a shield and was quite satisfactory in the prevention of scouring water on the cast iron.

5. Salt-water corrosion of the bolts and nuts. For the past few years all such bolts and nuts have been made of nickel steel, and no trouble has been experienced; but up to that time all bolts and nuts had had to be renewed once in two or three years.

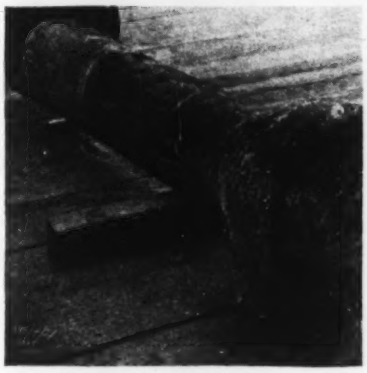
All breaks or leaks in the pipes are repaired by divers, and the repair of a break in that portion of the channel where the water is 40 ft. or more in depth is exceedingly costly.

The repair of a major break under water requires first cutting out the damaged part. This is done by drilling from 18 to 40 holes around the circumference and then with plug and feather severing

PIPE LINES across the First Narrows of Burrard Inlet were salvaged after the new pressure tunnel at that point was put into operation. This view shows the pipe drawn up on shore and separated into sections of ten or twelve lengths each.



PIPE SECTIONS were separated into individual lengths by melting the lead out the joints. Each joint comprised about 300 lb. of lead, and the time required for melting averaged about half an hour.



PIPE broken by internal pressure as a result of having been worn thin by sand abrasion caused by a jet from a leaky joint.

the pipe. The process is repeated on the other side of the trouble. A special is then slipped on, consisting of a flanged casting with a flanged stuffing box and heavy rubber gaskets at each end. The gland is brought up to the casting by bolts, and the rubber gasket is compressed with such force that it completely seals the ⅛-in. clearance between the casting and the pipe. If the alignment is bad, tierods are placed across the break and the job is complete. The standard special is 76 in. long. When more than one pipe is broken, two specials are used, either bolted together or connected by the correct number of flexible pipes.

All the underwater work is done by one diver. An air motor with the exhaust piped to the surface has recently been used for drilling the holes. Before that time a hydraulic motor with water piped from fixtures placed in adjacent submerged pipes was used, or the work was done with a hand drill.

Experience has shown that little is to be gained by endeavoring to continue work when the tides are unfavorable. Diving work now is planned to be done only at neap tides, and in general a repair can be made in a little over two weeks. The cost of the complete repair of a break, including specials, over a period of years has averaged around $1400.

When the District was formed in 1926, a regular crew with diver, diver's helper and others was organized, and a diving scow with compressor, tanks, gages, and all necessary equipment were specially built for this work. The diver and his helper are paid monthly salaries, and they work at other assigned duties when there is no diving necessary. All mains are examined at least once a year, and places of possible trouble are attended to so that many weaknesses which would eventually lead to breaks are eliminated. When the crew is not needed for actual diving oprations and other public bodies such as the sewerage board, the city, the provincial or dominion government require diving assistance, the work is undertaken, on an outlay only basis.

The District has other lines across False Creek and the north arm of the Fraser River, but on account of favorable conditions there has been little maintenance necessary.

On July, 1931, the contract for the First Narrows Pressure Tunnel was awarded, and from that time only sufficient maintenance was done on the pipes at that point to keep them barely operating (*ENR*, Jan. 4, 1934, p. 1). On its completion in June, 1933, the whole system of submerged pipe in that area was abandoned.

In June, 1934, the removal of these abandoned pipe lines was undertaken. A 60-hp. steam logging engine was set up on the south shore, where the foreshore is from 90 to 120 ft. wide, and the specials on the pipes were removed. Cables were then attached and a length of line was pulled as close to the engine as possible. The lead in the joint nearest low water was then melted with an oil jet flame, and the length of line (10 or 12 lengths) was rolled to one side where another crew with wood fire and oil jets melted out the lead from the remaining joints and broke the line down into its individual pipe lengths of 9 or 12 ft. The time required to melt out a joint was about half an hour. Practically all the lead (about 300 lb. per joint) was recovered. After the rolling of the shore piece out of the way the cables were again attached near low-water mark, and another section was landed and removed. Beyond where the specials had been, the diver had to attach the cables, and considerable time was taken for this part of the work.

Of the pipe recovered, 95 per cent can be reconditioned and used on other installations. The only wear noticeable on the pipes was in those section that occupied the contact area between the gravel and the sandstone. However, in each main salvaged there was from 100 to 500 ft. of the pipe buried so deeply in the sand and gravel that it could not be moved by the engine. Its place is recorded on the plans, and in the future, if necessary and considered economical, it may be removed by derrick scow.

The interior of the recovered pipe was badly tuberculated. On the exterior, where the pipes had been wholly covered or wholly bare there was little indication of wear, but where the pipes had been but partly covered the effect of moving sand and gravel, especially if there had been any leakage, was quite apparent.

Tests of salvaged pipe

One section of salvaged pipe consisting of a string of eleven pieces was tested under city pressure of 150 to 160 lb. The section tested was part of an 18-in. main laid in 1925. In its installation it had been pulled a distance of 400 ft. from the south shore toward the center of the narrows. In salvaging it had been pulled ashore against the bells for an equal distance, so that the length of pipe represented one that had undergone considerable rough treatment.

When pressure was first applied, there was noticed a slight sweating at the joints. Later these became quite tight. One joint had a perceptible leak which was calked. The leak was large enough to have been easily detected by the diver if it had been on an actual pipeline service.

Before the pressure was released, a piece of the pipe under test was moved laterally 4 ft., the limit of their allowable movement (iron to iron). There was no apparent leakage or sweating at any joint.

It was concluded from the tests that the joints are perfectly watertight if kept under tension, that the calking of the lead joints on the chute before pulling is wasted labor, that the tensile strength of a joint is almost as great as that of the 1⅝-in. pipe section itself, that before future pipes are pulled, experiments should be made to determine the probable safe tension for a joint, and that during installation a cable-tension indicator should be attached to the cables to determine the load as a greater length of pipe leaves the greased chute and is pulled through sand and gravel.

Methods and Cost of Filling for Highway over Swamps

A graphic presentation of recent practices of the state highway department of Michigan as reported to the Highway Research Board

By J. W. Cushing
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and O. L. Stokstad
Soils Engineer, Michigan Highway Dept., Lansing, Mich.

THE MICHIGAN state highway department began a careful study of the behavior of highway embankments constructed over peat marshes in the summer of 1925. The results of the early studies were expressed in rather complicated standards or methods, to be employed on subsequent construction projects. These methods usually involved the use of dynamite. In spite of what certainly was a great improvement over older practices, failures in the form of settlement (rapid and slow) continued. To overcome this weakness, methods were changed so fast that it became impossible to agree upon a standard procedure that could stay in effect and satisfactorily meet all situations.

For the past few years each swamp has been a subject for special study to work out methods of construction that seemed best able to satisfy the requirements. As a result of this procedure, certain methods have been used with such consistent success that standardized practices are again making their appearances. They are simpler than the earlier ones and indicate a more thorough knowledge of the factors involved in the displacement of peat by a mineral soil fill.

General discussion of practice

The present tendency in Michigan is to avoid the excessive use of explosives and to depend more on methods that seem to be very positive and easily controlled. The emphasis now is placed on such factors as the kind of fill material to be used and the proper timing of steps in the construction of the embankment. The latter factor is important because it permits the maximum advantage, resulting from the fluid character of peat and the greater weight of the fill, to be obtained. To avoid having to deal with comparatively dry and compact peat, such as forms below a heavy embankment, special attention is given to the point of filling. The high pressure in the peat at this point is being continuously relieved by mechanical excavation. Maximum fill weight is applied here by building the fill to surcharge grade or more by the end-dump method. Even when the peat is completely excavated, there is a proper time for placing the backfill. This is true especially when the excavation is deeper than 3 or 4 ft. The fill should be placed as the peat is being excavated, so as to prevent the sides of the excavation from sliding into the trench and to prevent the accumulation of disturbed peat in front of the backfill which, if allowed to accumulate, will become partly buried from time to time, causing weak spots in the embankment.

The necessity for choosing proper material for filling purposes cannot be overemphasized. Many of the more recent failures over peat swamps in Michigan are due to the warping or shifting of clay embankments rather than to movement in the underlying peat (Fig. 1). Sandy-gravelly soils should be used when they are available. On some heavily-traveled roads, where detours and temporary surfacings are a serious consideration, it is felt that a 3-mile haul may be justifiable to avoid a clay backfill.

After the embankment has been constructed to surcharge grade and the surcharge is to be left in place for a short time, level readings are taken at regular intervals to determine the rate and amount of settlement. As soon as progressive settlement has stopped the surcharge is removed and the grade is left for a period of about three months so that a new equilibrium may be established between peat and fill. It is also important that the portion of the fill that will support the future slab may be exposed to the elements to weather and reach a uniform compaction before the surfacing is placed. When the construction procedure results in total peat displacement as the filling progresses, the surcharge is not left in place but is moved forward with a bulldozer, so that only from 25 to 50 ft. of the embankment rests under surcharge at any one time.

A temporary surface is often placed when it is necessary to route traffic over a recently constructed embankment across a deep peat swamp. The temporary surface is left in place for one to three years, depending on the depth of the peat deposit, kind of fill material, the completeness of the peat displacement and the rate of settlement.

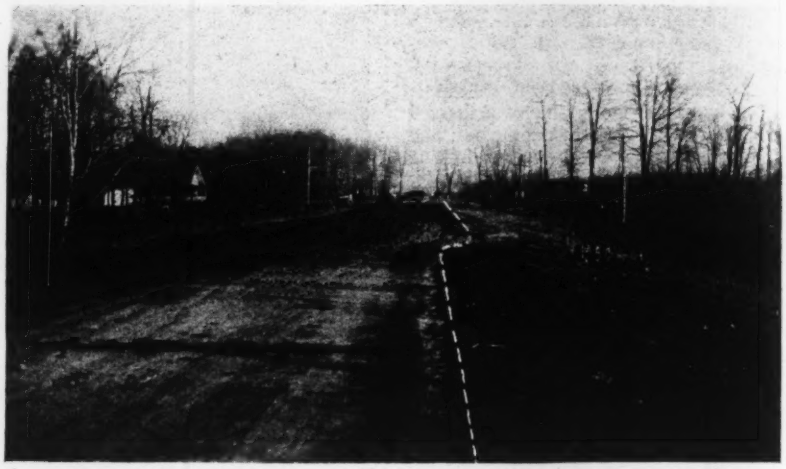

FIG. 1—WARPING OF ALIGNMENT due to side slip of clay fill over swamp muck. Sandy-gravelly soil should be used for all fills.

The diagrams which follow illustrate methods or procedures which have become more or less standardized during the last three years. These methods are considered basic and are varied when necessary to meet any abnormal swamp conditions encountered.

Details of practice

Referring to the numbered graphs shown in Fig. 2, the general details of seven typical methods are briefly described as follows:

1. *Deep Grubbing*—This method has been used to a limited extent in the shallow timbered swamps, occurring principally in the northern part of the state. The chief disadvantage is the difficulty encountered when the ground is frozen; deep grubbing does not lend

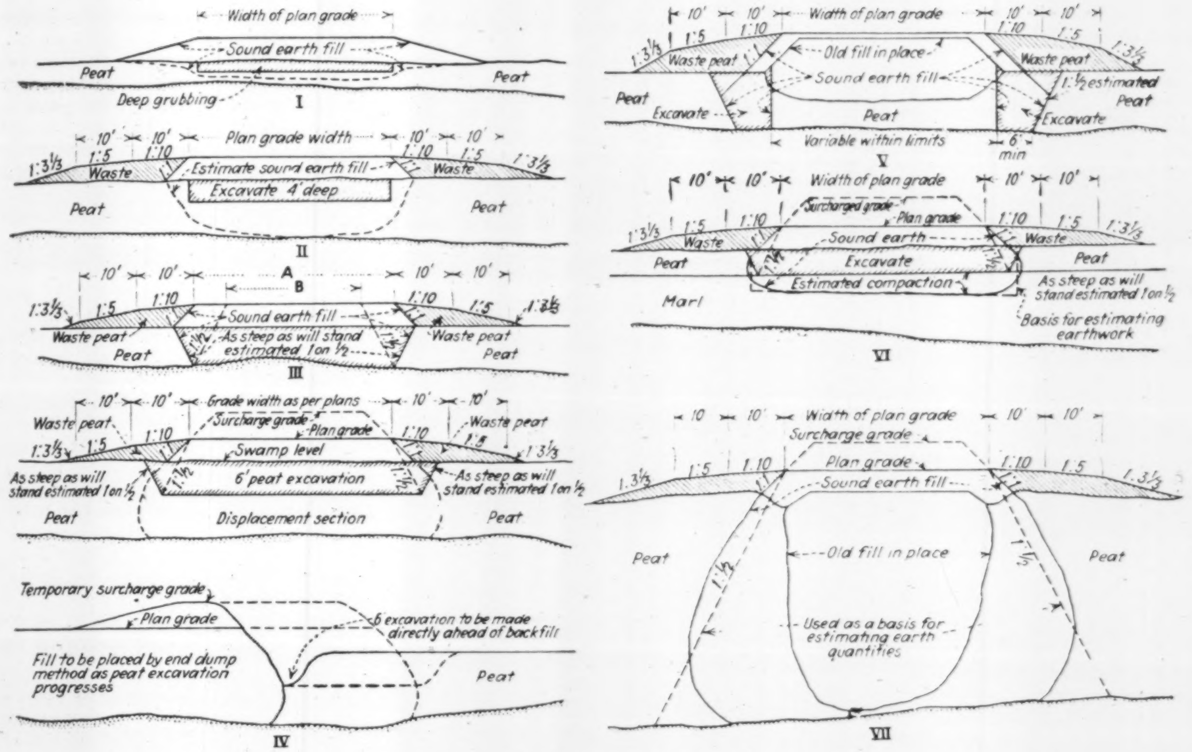
Width of plan grade
Sound earth fill
Peat
Peat
Deep grubbing
I
10' 10' Plan grade width 10' 10'
1:3⅓ 1:5 1:10 1:10 1:5 1:3⅓
Waste
Estimate sound earth fill
Waste
Excavate 4' deep
Peat
Peat
II
10' 10' A 10' 10'
B
1:3⅓ 1:5 1:10 1:10 1:5 1:3⅓
Sound earth fill
Waste peat
As steep as will stand estimated 1 on ½
Waste peat
Peat
Peat
III
10' 10' Grade width as per plans 10' 10'
Waste peat
Surcharge grade
Plan grade
Waste peat
1:3⅓ 1:5 1:10 1:10 1:5 1:3⅓
Swamp level
1:1½
6' peat excavation
As steep as will stand estimated 1 on ½
As steep as will stand estimated 1 on ½
Peat
Displacement section
Peat
Temporary surcharge grade
Plan grade
6' excavation to be made directly ahead of backfill
Fill to be placed by end dump method as peat excavation progresses
Peat
IV
10' 10' Width of plan grade 10' 10'
1:3⅓ 1:5 1:10 1:10 1:5 1:3⅓
Waste peat
Old fill in place
Waste peat
Sound earth fill
1:½ estimated
Peat
Peat
Excavate
Peat
Excavate
Variable within limits
6' min
V
10' 10' Width of plan grade 10' 10'
Surcharged grade
Plan grade
1:3⅓ 1:5 1:10 1:10 1:5 1:3⅓
Waste
Sound earth
Waste
Peat
Excavate
Peat
Estimated compaction
As steep as will stand estimated 1 on ½
Marl
Basis for estimating earthwork
VI
10 10' Width of plan grade 10' 10'
Surcharge grade
Plan grade
1:3⅓ 1:5 1:10 1:10 1:5 1:3⅓
Sound earth fill
Peat
Old fill in place
Peat
1:⅓
1:⅓
Used as a basis for estimating earth quantities
VII

FIG. 2—BASIC METHODS of making swamp fill employed by the Michigan state highway department.

itself to winter work. This method requires a fill at least 3 ft. thick, to prevent the highway from breaking through in the spring, and is recommended only when the highway is to be surfaced with gravel or related materials.

2. *Practical Excavation for Secondary Roads*—This method is recommended for projects on which the type of construction does not warrant the cost of complete excavation of the peat. Dynamite may be used for excavation, especially if the swamp is soft and wet. Experience indicates that the fill settles practically to the bottom of the swamp at the time of construction. To prevent the moving peat from piling up in front of the advancing fill, it is highly important that the backfill be placed as the excavation progresses. When dynamite is used, not more than 50 ft. of trench should be shot at one time. The embankment should be built of the most sandy-gravelly material that is available.

3. *Full Cut Through Shallow Swamps*—Complete excavation of peat in swamps up to 8 ft. in depth is recommended for all highways on which a rigid or semi-rigid surface is to be placed. The unique part of the method represented by this cross-section is that the width of excavation varies with the distance from plan grade to swamp bottom. As this distance increases, the width of excavation also increases by an equal amount. It is important that the embankment be built of sandy-gravelly soils, especially in the deeper excavations.

4. *Partial Excavation and Surcharge*—The procedure illustrated has proved to be very effective in displacing peat in the depth range between 8 and 20 ft. This range gave considerable trouble under older methods of construction. The secret of the success of the method lies in relieving the pressure at the advancing toe of the embankment. The process of relieving this pressure can be accomplished both by dynamite and by machine excavating. It is highly important again that sandy-gravelly filling materials be used. The surcharge is usually brought forward with a bulldozer as construction proceeds, because its only purpose is to add weight at the point of loading.

5. *Side Excavations on Old Locations*—In rebuilding a highway, swamp fills are often encountered that are of such stability and size that they may be left without being disturbed. The new fill, however, is usually wider than the old; and so that the sides of the new embankment may be as stable as the center, resort is usually made to side excavation. This method is used in shallow swamps, and the side trenches may or may not be excavated to the bottom depending upon the importance of the highway. Here again the trenches should be filled as the excavation progresses, partly as a safety measure and partly to prevent sliding and caving. The distance between the trenches must vary with the width of the old fill, but outside limits need not extend beyond the area indicated as sound earthfill in the diagram.

6. *Construction Over Marl*—Deposits of marl will support highway embankments if they are first properly compacted. The amount of compaction of course depends on the height of the grade above swamp level and the amount of water and organic matter contained by the marl. The average deposit of marl compacts to about two-thirds its original depth. The surface mat of peat should be excavated and the trench filled as the excavation progresses, to prevent the accumulation of large amounts of disturbed peat in front of the backfill. The backfill need not and probably should not be built to surcharge grade or even to plan grade as the excavation progresses. Rather the fill above the swamp level may be built in layers or lifts until a stable surcharge grade is obtained.

7. *Rebuilding Over Deep Swamp*—The force of gravity is the greatest aid in securing a proper cross-section in a swamp as deep as the one illustrated. The great weight of so large a fill is usually sufficient to displace most of the peat. Often, however, dynamite or jetting must be employed to obtain adequate bottom width in the embankment. This is especially true where there is an old fill in place to be settled and widened. To hold the embankment within the reasonable limits shown by the diagram, it is necessary that a sandy-gravelly filling material be used. Clay fills in deep swamps have a tendency

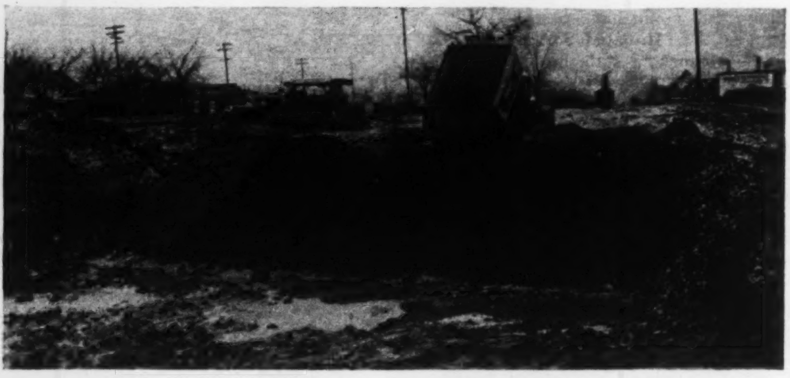

FIG. 3—BACKFILLING with sand a trench excavated in swamp peat.

to spread to unusual widths at the bottom. Swamp ditches should be omitted except when needed as farm drains, because of their disturbing influence on the new equilibrium to be maintained between the fill and the surrounding peat.

Jetting method

This method has been used with varying success on nine projects in Michigan. The degree of success seems to have varied with the kind of fill material used, age of the fill before jetting was started, location of the jets, type of pumping equipment used and the composition of the peat materials. Such experience as has been had with the jetting procedure seems to warrant a few statements regarding the method to be considered in future work to obtain the best results.

1. The filling material should be of a sandy-gravelly nature. Soils high in clay content have a tendency to "set up" after being placed and therefore respond more slowly to movements in peat resulting from jetting operations. Clay fills also have a tendency to flow laterally in the deeper swamps. This action might be exaggerated through the use of the jetting method under some conditions.

2. The jetting should be carried on at the same time that the fill is being placed so as to keep the peat as fluid as possible while it is being displaced. Experience indicates that to make the peat fluid enough to flow is a slow and difficult process after it has become compacted and partly dried out by the weight of the overlying fill. It is consequently suggested that water be pumped into the peat before the fill is being placed and as long thereafter as the fill continues to settle. Borings will indicate where extra jetting is necessary.

3. It should be remembered when locating the jets that the peat to be displaced is the peat which should be kept wet, and also that the more fluid this peat becomes the more easily it is displaced. A single line of jets along each side of the embankment is not sufficient. Instead they should be placed from 10 to 25 ft. apart over the entire area to be occupied by the embankment.

4. Equipment that has been operated effectively in Michigan consists of a 5-in., three-stage centrifugal pump powered by a six-cylinder, 90-hp. engine. This unit has a capacity of 500 gal. of water per minute at a 250-ft. head when operating at 1,450 r.p.m. and is guaranteed to operate fifteen jets, each having five openings of 7/32-in. diameter. Twenty jets can successfully be operated with a motor speed of 1,700 r.p.m.

5. The presence of sand or marl in a swamp deposit has a very marked influence on the displacement that can be obtained through the use of the jettin method.

6. The jetting method requires a adequate supply of water located nea the swamp such as a stream, pond o drain.

7. Continuous operation seems to b more effective than interrupted operation.

Cost data

The numerous reports dealing wit accelerating fill settlement in pea marshes contain considerable information on methods used in different state but very little information on the cost involved.

The state board of public roads o Rhode Island maintains that in the cas of shallow swamps, if fills can be successfully made by the blasting method, a considerable saving in costs is effecte and the cost of blasting by the propagation method is less than one-thir the cost of excavation. Rhode Islan also gives some costs on a grade buil over 110 ft. of salt marsh varying i depth from 10 to 15 ft. (*ENR*, June 1, 1933, p. 715). It was estimated tha

A COST SUMMARY OF METHODS USED IN THE CONSTRUCTION OF HIGHWAY EMBANKMENTS ACROSS PEAT SWAMPS

Method Used	No. of Swamps Considered	Total Cu.Yd. Subfill	Total Cost	Cost Per Cu.Yd. Subfill*
Partial excavation with surcharge (Michigan)..	4	117,955	$12,444.88	$0.1055
Water jetting — costs include some special peat excavation (Michigan)..	9	479,077	28,282.93	0.0787
Dynamiting and surcharge —deep shooting used (Michigan)..	13	157,038	14,531.03	0.0925
Trench blasting and deep shooting (Minnesota).	44	628,513	63,865.66	0.1016
Stabilizing old fill in place — relief trenching and deep shooting (Minnesota).	13	168,684	21,296.86	0.1263
Combination of mechanical excavating and dynamiting (Minnesota).	25	394,407	49,253.07	0.1249

*Subfill refers to that part of the highway embankment which is located below the original swamp level

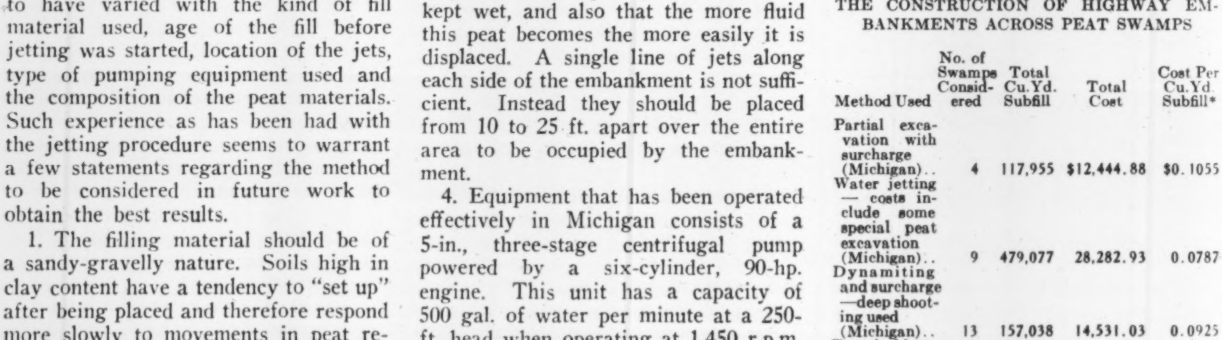

FIG. 4—JETTING PUMP and method of liquefying swamp peat to permit settlement of fill.

40,000 cu.yd. of material would have to be excavated and wasted. Contractors wanted 90c. per cubic yard for removing this material, which would result in an approximate cost of $32,000. The fill was constructed with the use of $15,000 worth of dynamite; 50,000 cu.yd. of fill were used instead of the estimated 75,000 cu.yd. The estimated savings in cost over what dredging would have cost was $20,000.

It would seem that 90c. per cubic yard for excavating the peat is excessive. By carrying the excavating machine forward on the advancing fill the peat excavating should be done for the regular earth-excavation price: 40,000 cu.yd. of peat excavation at 30c. per cubic yard would have cost $12,000, instead of the estimated $32,000.

The Minnesota state highway department has done more to develop costs of highway construction over peat marshes than any other state.

Peat that has been highly compressed and dewatered by the weight of a heavy fill is very difficult to displace. For this reason it would seem logical to conclude that any method that results in complete peat displacement as the filling progresses should be economical of both time and material. This should be particularly true in the case of dynamiting or water jetting.

A careful study should be made of each swamp with respect to the character of the peat and condition of the existing embankment, so that an economical and effective construction procedure may be planned.

At the present time it seems that swamps up to 8 ft. in depth should be excavated to the bottom ahead of placing the backfill, that swamps ranging in depth from 8 to 25 ft. should be treated as indicated by the method labeled "partial excavation and surcharge," and that swamps of greater depth than 25 ft. should be jetted, provided that an adequate supply of water is available. There will be some overlapping in the use of the last two methods, depending on conditions encountered on each particular project.

Sewage-Plant Survey—XII

Data from Allentown, Pa.

The Following Article is the twelfth of a series presenting in brief form the salient design and performance characteristics of American sewage plants. Articles already published have presented data from the following cities: Decatur, Ill., Cleveland, Ohio, Schenectady, N. Y., Aurora, Ill., Lima, Ohio, Grand Rapids, Mich., Urbana, Ill., Baltimore, Md., Toledo, Ohio, Akron, Ohio, and Rockford, Ill.

During 1933, its first year of complete operation, the sewage-treatment plant of Allentown, Pa., removed 85 per cent of the B.O.D. and 83.5 per cent of the suspended solids from the city's sewage before discharging it into the Lehigh River. Detailed design and performance data for the year are given in the following tabulation.

Allentown's sewage plant, situated at Kline's Island, comprises a coarse screen, detritus tank, Imhoff tanks, trickling filters and secondary settling tanks. The plant was designed by Metcalf & Eddy and the city engineer, Earl Meckley, to provide for a population of 128,000. The Imhoff tanks were put in service in December, 1929, but due to litigation over the award of the contract, the trickling filters were not available for use until June, 1932. The total cost of the plant to date is estimated to be $1,500,000.

Sewage is collected in Allentown by a separate system of sewers. The sewage flows by gravity through the coarse bar screens into a pump suction chamber. Low-lift pumps then raise the sewage to the detritus tank, from which it flows by gravity through the various units.

During the greater part of the year reported, the sewage flow was confined to three of the Imhoff tanks. On various occasions, however, only two tanks were used because of foaming in the third tank.

Two of the Imhoff tanks are provided with three gas-collection domes each. These domes are connected by 2-in. pipe to the fire box of an incinerator. Sufficient gas is collected to burn all the pressed skimmings and screenings. The ash from the incineration of 3,130 cu.ft. of pressed cake amounted to 366 cu.ft.

The plant is also equipped with three chlorinators, each having a capacity of 300 lb. per day. The average amount of chlorine added to the filter effluent was 27.3 lb. per million gallons, or 3.28 p.p.m.

The analytical data relative to the efficiency of the trickling filter are not dependable because of the great difficulty encountered in collecting a true sample. The filter effluent flowing into the final settling tank is chlorinated before it enters the tank, so that samples taken at the entrance will not reveal the true trickling filter efficiency.

Data presented herewith have been made available by Harry J. Krum, city chemist and bacteriologist.

SEWAGE-PLANT PERFORMANCE DATA, ALLENTOWN, PA.

GENERAL DATA

Population, 1933	95,500
Population served, 1933	50,255
Rated capacity of plant, m.g.d.	17.3
Sewage flow	...
Average m.g.d	5.4
Maximum day, m.g.d	9.4

SEWAGE-TREATMENT UNITS

Coarse Screens

Number of units	1
Width of opening, in	3
Angle of screen with horizontal degrees	60
Method of cleaning	Manual

Detritus Tanks

Number of units	2 (1 in use)
Diameter each unit, ft.	30
Operating depth including grit space, ft	21
Average flow, each unit, m.g.d.	5.4
Detention period at actual flow, each unit, min.	25
Method of cleaning	revolving scrapers
Frequency of cleaning	three times daily

Fine Screens

Number of units	2
Type	revolving drum
Width of opening, in	⅛

Imhoff Tanks

Number of units	6
Plan dimensions, each unit, ft.	75x65
Settling compartment	
Surface area, each unit, sq.ft.	4,875
Depth to slot, ft	12¼
Area of cross-section, sq.ft	1,657
Sludge compart., each unit, cu.ft.	72,500
Gas-vent area, each unit, sq.ft	157.5
Sewage flow, all units, m.g.d.	5.4
Detention period, all units (actual flow), hours	3
Frequency of sludge removal, each unit, times per year	2

Trickling Filters

Number of units	4 (2 in use)
Area, each unit, acres	1.3
Sewage flow, all units, m.g.d.	5.4
Type of filter material	crushed limestone
Depth of filter material, ft.	10
Type of distributing system	spray nozzle

Secondary Sedimentation Tanks

Number of units	4 (2 in use)
Diameter, each unit, ft	70
Operating depth, including sludge space, ft.	13
Sewage, flow, all units, m.g.d	5.4
Detention period at actual flow, both units, hr.	1.5

SLUDGE DISPOSAL

Sludge-Drying Beds

Number of units	68
Length each unit, ft.	80
Width each unit, ft	18
Depth of sand, in	9
Depth of sludge applied, in.	10
Thickness of dried cake, in	3

ANALYTICAL RESULTS

	Suspended Solids, p.p.m.	Total Solids, p.p.m.	Five-day B.O.D., p.p.m.	Settleable Solids, c.c. per liter (2 hr.)
Raw sewage	218	698	281	6.2
Imhoff tank effluent	92	571	109	1.1
Trickling-filter effluent	216	..	187	...
Secondary-tank effluent	36	526	41	0.2

SCREENINGS AND SLUDGE

	Volume, Cu.Ft. Per M.G.	Dry Solids, Per Cent	pH	Disposal
Coarse screenings	0.4	....	...	Incineration
Fine screenings	2.9	37.0	...	....
Imhoff-tank sludge	112	7.8	6.9	To drying beds
Dried sludge	10.9	65.0	...	Given away to farmers

Long Life for Wood-Stave Pipe Indicated by Denver Experience

Recent experiment leads to partial perforation of staves to ensure water saturation and give added life—A life of 40 to 45 years indicated, with staves outliving bands

FIFTY YEARS AGO, in 1884, the first continuous wood-stave pipe line was built in Denver, Colo., and during the years that followed the city constructed many miles of conduit of this material. As none of these lines lasted longer than 45 years, the city's experience more than covers the life span of the material. Although the building of new wood-stave lines was abandoned some years ago, there are still many miles of it in service. The present condition of the existing lines and the maintenance and replacement policies of the Denver Board of Water Commissioners are described in the following article.

During the last two years the water board has adopted the practice of perforating the lumber used in rebuilding the conduits, with the object of preventing decay by ensuring the saturation of the material. Experiments had indicated that this practice would be effective and would add to the life of the line.

In 1924 the board had constructed 10 miles of 66-in. continuous wood-stave pipe; the staves were milled from fir lumber obtained from the Northwest. This conduit line, known as No. 11, parallels another conduit 48 in. in diameter, constructed of the same material in 1911 and known as No. 7. Conduit No. 7 had given good service up to the time the new line was built. In 1932 it was discovered that a stretch of several thousand feet of Conduit 11 was in bad condition and required rebuilding, because a considerable portion of the staves had failed from dry rot. A few feet away, however, at this point was the older conduit, still in good condition. Both conduits operate under the same conditions at the place of decay where the water pressure was about 25 lb. Essentially the only difference was that Conduit 7 was built of staves 1⅝ in. thick, and Conduit 11 was built of staves 2½ in. thick. When Conduit 11 was designed, the proper thickness of staves had recieved much consideration. Due to the fact that the pipe line was to be 66 in. in diameter, the engineers in charge of the work were apprehensive that the conduit would collapse under the weight of the backfill if staves thinner than 2½ in. were used. Hence this thickness, which is about that usually employed in pipe of this diameter, was adopted.

When it became apparent that it was necessary to rebuild the section of the newer conduit, the use of steel or concrete was discussed, as was also the advisability of using thinner staves. It was finally decided to rebuild the conduit of material similar to that originally used, but to take some measure to ensure longer life.

Staves partly perforated

Fred Binner, foreman, suggested the use of perforated lumber, and D. D. Gross, chief engineer, asked C. L. Adams, superintendent of the Bear Creek division, in which most of the wood-stave pipe-line mileage lies, to conduct experiments to determine the benefits that might be expected. A number of tests were made. First a ⅜-in. hole was drilled part way into a piece of stave lumber, and a water pipe was screwed into the opening; water under 15 lb. pressure was then introduced into the pipe.

It was clearly demonstrated in the course of the experiment that the annular rings of the fir lumber offered resistance to the passage of water, and that under light pressures the wood remained dry on the outer portions of the stave. Water would follow along the annular rings that had been pierced by the drill hole for a distance of 2½ ft. in a few minutes but would penetrate across the annular rings for a distance of only ⅛ to ¼ in. As the water pressure was increased, additional areas of the stave were permeated.

It was found that one drill hole placed in a stave would not pierce a sufficient number of the annular rings to ensure saturation across the width of the staves. Hence, in practice, three drill holes are placed across the nearly 6-in. width of stave, staggered a few inches apart in order not to weaken the lumber. The perforations, ⅜ in. in diameter, are drilled from the inside of the stave to within less than ½ in. of the outside. The holes are arranged in staggered groups of three spaced at 3-ft. intervals. With twist drills of the proper length and by the use of electrically driven equipment, these perforations can be made rapidly. Even under pressure as low as 15 lb. they ensure the saturation of the wood.

As an added precaution against decay, the outer surface of the stave is given a coat of carbolineum before it is used in pipe construction. Further, the outside surface of the completed conduit line is given a coating of asphalt paint.

Continuous wood-stave pipe was an invention of C. P. Allen, former chief engineer of the Citizens Water Co. and later of the Denver Union Water Co. The first pipe of this kind was laid in 1884 within what is now the city limits of Denver. (See *Engineering News*, Vol. 20, 1888, pp. 222 and 240.) For 45 years this original conduit was in use until it was abandoned in 1929. A similar line, constructed under Mr. Allen's direction in 1893, is still in use. It is 34 in. in diameter and 22 miles long. Concrete pipe was used at the high points where the grade of the pipe line approached the hydraulic gradient. In many locations it has been necessary to reband the pipe two or even three times as the original bands corroded. Most of the original lumber and many of the original bands are still in service, but in general the conduit line at the present time is not in good condition; still it is capable of carrying about 8 m.g.d.

Wood-stave conduits have played an important part in the development of Denver's water-supply system. In 1890, when it was necessary for Denver to go a distance of 25 miles to get an additional water supply, wood-stave pipe was the cheapest and easiest material to use. The argument used in its favor was that it was cheaper to put in a wood-stave pipe and rebuild it when necessary than it was to pay interest on the cost of a more permanent construction. This contention, under favorable conditions for the use and long life of wood-stave pipe, is still considered tenable by the engineers.

A number of years ago the Board of Water Commissioners adopted the policy of not building new wood-stave conduit lines to carry filtered water into the city, although they still continued their use as a means of getting raw water from the river to the settling reservoirs. Although some of the old wood-stave conduit lines still remain in service, the major portion of Denver's water supply is now brought into the city through 60- and 66-in. conduits built of concrete and steel.

At one time Denver had more than 100 miles of wood-stave conduits in use; at the present time the mileage is 73. The main reason given for abandoning the conduit lines as carriers of filtered water is that topography near Denver is not favorable for their use. After the lines have been in use a few years there is always danger of breaks occurring, especially at summits, thus putting a portion of the city out of water, or of bringing in muddy water. These breaks are not so serious in the case of raw-water feeders to the reservoirs.

The maintenance and operation of the pipe-line system supplying Denver with water from the several mountain sources is under the direct charge of D. D. Gross, chief engineer, reporting to E. G. Plowman, executive assistant to the Board of Water Commissioners. C. C. Schrepferman is manager of construction.

Active Division Meetings Mark Civil Engineers' Convention

Two sessions each of sanitary, structural, power and city planning—One session held by waterways, surveying and mapping and the combined construction and highway division—Board of direction expands professional work of the society

THE eighty-second annual meeting of the American Society of Civil Engineers, held in New York Jan. 16-19, was marked by unusually active interest in the sessions of the technical division. It was marked also by decisions on the part of the board of direction to enlarge the professional activities of the society, action that was taken in response to feeling that has been more and more evident within the society during the past five years that it should concern itself with professional problems much more than it has in the past. The board of directors' action was reported in last week's issue, p. 108. Briefly, the board authorized its executive committee to aid members in the defense of their rights, approved active efforts to correct current abuse of civil service rules and took steps to promote the adoption of adequate registration laws for engineers. The board also authorized the naming of junior members to society committees wherever practicable.

Conferring of three honorary memberships and the induction of the new president, Arthur S. Tuttle, of New York City, were features of the opening session. Honorary membership was conferred upon W. L. Darling, of St. Paul, Minn.; Robert Ridgway, New York, and posthumously to Dean Milo S. Ketchum.

In addition to the election of Mr. Tuttle, the tellers reported the election of D. H. Sawyer and H. E. Riggs as vice-presidents, and six new directors: C. A. Poole, Herman Stabler, J. L. Ferebee, C. B. Burdick, H. S. Morse, I. C. Crawford and T. A. Leisen.

The society's medals and awards were presented to L. S. Moisseiff, M. I. Killmer, Prof. H. M. Westergaard, J. C. Evans, and jointly to E. W. Bowden and H. R. Seeley and to G. H. Hickox and G. O. Wessenhauer.

Waterways

Two subjects were considered by the waterways division, recent and proposed improvements in the Cape Cod Canal and the increased activities of marine wood-borers on the New England coast. Lieut. E. C. Harwood, of the district engineers office in Boston, reviewed the history of the Cape Cod Canal and gave statistics to show the regular growth in canal traffic and the evidence of need for a canal of much larger capacity, to accommodate the potential traffic.

Enlargement of the canal, widening it to 170 ft., has been in progress for some time past, and it is now proposed to widen the channel to 540 ft. and to deepen it to 32 ft. Without locks, which is the favored plan, the cost would be $23,170,000. A lock canal would cost $27,500,000. A program of construction covering five years has been laid out. Reconstruction of the bridges crossing the canal has been in progress for some time past, the two highway bridges being replaced by fixed spans with an underclearance of 135 ft. and the railroad bridge being replaced by a lift span giving a clear channel of 500-ft. width and an underclearance of 135 ft. in open position.

In discussion, C. A. Farwell, of the firm of Fay, Spofford & Thorndike, consulting engineers on the highway bridges, outlined the reasons back of the selection of the type of bridge adopted for the highway crossing, and Eugene L. MacDonald, engineer of the firm of Parsons, Clapp, Brinckerhoff and Douglas, described the railroad bridge, the longest lift bridge in the world, and also gave an account of the difficulties involved in the construction of its foundations. Walter J. Douglas, of the same firm, who was associated with the late William Barclay Parsons, engineer for the original canal, told of some of the difficulties of the early days, especially the difficulties with the glacial boulders encountered in the foundation work for the new bridges.

Mr. Douglas referred to the fact that it had been suggested that the lift span, on account of its great length, be built of aluminum in order to reduce the moving loads greatly. He stated, however, that while the idea appeared to be a good one, there was not enough information available regarding the use of aluminum for such a large structure, to warrant its adoption.

Frank C. Shepherd, consulting engineer of the Boston & Maine Railroad, outlined in considerable detail the results of extensive tests now being conducted along the New England coast to determine the extent of the activities of marine borers. Within recent months, many indications have been found of renewed activities or activities in regions heretofore practically free from attacks by marine borers. The studies are being carried on between New York and Eastport, Maine, with test boards submerged at key points and test blocks attached to the boards, which are removed and checked monthly to determine the amount of attack by teredo and limnoria. The results are being checked against a somewhat similar study made about ten years ago. Some sections have been found to show much greater activity, while others show little change. The heaviest attacks have been concentrated in Boston harbor.

Velocity-measuring devices

The first session of the power division was devoted largely to a discussion of velocity-measuring devices used in hydraulic studies, the recently developed Bentzel velocity tube and the Pitot tube. Lieut. F. H. Falkner, of the U. S. Waterways Experiment Station, Vicksburg, Miss., described the device developed in that station by Carl E. Bentzel for measuring small velocities in flowing water. The Bentzel tube was described in *Engineering News-Record* on April 19, 1934, p. 508.

Development of the Pitot tube was the subject of an historical statement by Edward S. Cole (Pitometer Co.) as an introduction to an account of the study he had been conducting recently. Mr. Cole's recent studies have been devoted largely to the calibration of tubes at Worcester Polytechnic Institute and at the University of Pennsylvania.

A review of 40 years of comparative tests carried on at Worcester Polytechnic Institute was included in a paper by C. M. Allen and L. J. Hooper, entitled "Comparative Measurements of a Venturi Meter and a 10-Ft. Weir."

Norris and Wheeler dams

The two dams now being constructed by the Tennessee Valley Authority were the subject of discussion at the second session of the power division. Barton M. Jones and Wilfred M. Hall, construction engineers of the Tennessee Valley Authority, described the design and construction features of Norris and Wheeler dams. A third paper on TVA operation, "Regulation of the Tennessee River," in the absence of the author, was read in part by L. F. Harza, Chicago, in order to bring out its salient features for discussion. Mr. Harza pointed out that the Tennessee Valley Authority will have an exceptional opportunity to put many current theories on river control and regulation into practice on a scale heretofore never possible because it will be able to direct the regulation and control work in a whole river basin of unusual size.

The papers on Norris and Wheeler

dams were unusually complete as to detail of the design and construction features. Interest in both dams centered largely in the foundation problem, although at Norris dam the design brought forth considerable comment.

Norris dam is founded on a heavy dolomite which lies in thick, nearly horizontal, bedding planes with some clay seams and some solution channels. Elaborate precautions are being taken to make the underlying rock tight, work that has included an unusual amount of foundation exploration, including the taking out of many feet of 36-in. cores, giving holes in which it was possible to make a direct examination of the rock.

Discussing the design of the dam, L. J. Bevan said that the Bureau of Reclamation's finding that silting resulted in no added pressure on the dam was contrary to accepted engineering belief and the demonstrations. If silt pressures are assumed, the resultant falls outside the middle third of the dam, unless uplift is disregarded. In reply, Mr. Jones stated that accumulations of silt at the face of the dam would be so slow that there never would be any depth of unconsolidated silt; that extensive studies in the Miami Conservancy District's work had indicated that with consolidated silt, pressures against the face of the dam would not exceed water pressures.

Because of the somewhat similar foundation conditions found at Wheeler Dam, extensive exploration of the foundation rock and elaborate grouting also are being carried on there. Asked as to the advantage of the 36-in. drill holes over the smaller drill holes normally used, Mr. Hall stated that with the small drill holes the core frequently is lost, and knowledge then must be gained from an examination of the hole with a periscope, whereas direct examination can be made in the 36-in. hole. He said the large holes cost from $10 to $15 a foot. Mr. Jones cited one instance in which a saving of $50,000 had been made as a result of the positive knowledge obtained from larger holes, knowledge that could not be obtained definitely from a small hole.

Surveying and mapping

With a record attendance and unusual interest displayed, the surveying and mapping division held a session which centered on the necessity for a national mapping program as a direct result of the present national planning and resource study. A paper, "National Planning Compels National Mapping," by F. H. McDonald, consulting engineer, Atlanta, reviewed the present status of the national mapping, both as to extent and adequacy, and then outlined the necessity for the rapid completion of the present program if national planning and the development of natural resources are to have the proper basic information. He characterized much of the early mapping as artistic but not accurate and pointed out that although about 45 per cent of the country had been covered by topographic mapping, only one-half of this, or about 25 per cent of the area of the country, is considered adequate, which leaves 75 per cent of the country as yet inadequately mapped.

The past history of cooperation with states in carrying out the mapping program was considered entirely inadequate by Mr. McDonald, who advocated a federal consolidated mapping agency to eliminate duplication and provide the efficiency of centralized control.

As a result of the control work that is now being extended, making U.S.C. &G.S. monuments available, there will be an increasing need for precise work in the future, and many of the present surveyors have not the training and experience to carry on this work. Further, he contended that the present engineering courses in colleges were not designed to give this type of work to students.

A "proposed system of state surveying and mapping information bureaus" was outlined by Prof. J. S. Dodds, Iowa State College. He reviewed the advantages of having a single mapping agency in each state which would be the depository for all maps prepared in the state, or at least the source of information as to what maps were available. This agency, in each state, would also be a source of information as to federal maps available.

City planning

The effect of the depression on city planning and the existing possibility of using relief work to expedite city-planning programs, which have been greatly curtailed within the past few years, provided the main theme of the planning division at the morning session.

A paper by W. F. Cavanaugh, highway commissioner and planning engineer, Milwaukee County highway department, on "Milwaukee County Park and Parkway Development, a Depression Activity," presented an extended review of the park development work carried on with relief labor, stressing the fact that this work was made possible by planning that had been done in advance of need.

A paper on the subject, "Must Planning Go on the Shelf During a Depression?" by Russell V. Black, city planner, New Hope, Pa., presented a stimulating general review of the problem, indicating that planning should not be shelved, but generally is. The reason for this tendency to stop planning operations during a depression was attributed by Mr. Black to (1) overselling or (2) underselling. In the first case, the advocates of planning have sold the city administration the idea of large-scale and costly work to be done by planning, so that during the depression city officials are at once convinced that the program is entirely too large for current finances and the whole mater is held in abeyance. By underselling, Mr. Black meant that the administration and the general public had not been sufficiently convinced of the economic and financial soundness of the planning program, and it was still considered principally a sop to certain groups which could be made available during flush periods of municipal financing but had to be dispensed with with curtailed revenue.

The use of relief funds and relief labor for making city planning surveys and research was referred to in a paper by T. T. McCrosky, planning director, city planning commission, Yonkers, N. Y., as "an unparalleled opportunity." He pointed out that at the present time many city planning agencies have been reduced, because of stringent finances, to the usual unpaid planning commission, which has no time or technical help in furthering city planning. By the use of relief labor Mr. McCrosky outlined a program that would give personnel available in large numbers to carry out surveys and collect essential data from which city planning could be carried out at a later date by the skeleton staff still maintained.

Slum clearance

Slum clearing and the improvement of blighted areas, as the problem applies to New York City, were reviewed by Maurice Deutsch, architect and engineer, New York, who presented several of his plans for definite slum areas based on four-story multiple dwellings occupying about 40 per cent of the gross area.

"The real property inventory" was described by H. W. Green, Cleveland, as this new development for city planners was originally developed in Cleveland and was subsequently used by a federal government survey in representative cities throughout the country. Mr. Green reviewed some of the results of the survey, indicating that general figures for an entire municipality, as determined by the census, do not have the value for city planning that is obtained by the use of census units in the presentation of data. Some striking examples were cited as to the growth and decay within various units of the city, which were entirely different from the general data for the city as a whole. As a definite indication of the growth and decline of the city's nucleus, he cited figures to show that, for example, population in the original city areas of Cleveland and St. Louis was today considerably less than the population in those same areas in about 1850.

Traffic engineering, as one of the newer branches of the art, was reviewed as to its development and general characteristics by Sidney J. Williams, director, public safety division, National Safety Council, Chicago. An analogy was pointed out between the traffic engineer and the hydraulic engineer in that the traffic engineer studies a fluid and is interested in its volume, speed and peculiar characteristics, such as turbulence and eddies, in much the same manner as the hydraulic engineer studies water.

Structural analysis

A symposium on "Common Sense in Structural Design" made up the most active part of the two sessions of the structural division. Participants were Prof. Hardy Cross, of the University of Illinois, Urbana; Glenn B. Woodruff, engineer of design of the Bay Bridge, San Francisco, and Albert W. Smith, structural engineer, Chicago.

Professor Cross considered his theme from the analytical viewpoint, but in fact argued forcefully for the practical attitude toward structural design. He pointed out that analysis has definite and rather narrow limits of use to the structural man: it is most important as a guide to selection of the type of structure for the desired or the most efficient action, as in avoiding indeterminate forms that are intrinsically undesirable by being easily affected by minor change of conditions, or again in proportioning an arch to locate the principal bending resistance in the deck framing or in the rib. Analysis in the hands of the designer, Professor Cross indicated, should be primarily a means of attaining most practical design.

Mr. Woodruff cited a number of ways in which the material, the site conditions or factors of construction make design sense more important than calculation. Fixed design data like building-code rules often conflict with the facts of the work, as represented in uncertainty and variability of foundation-soil conditions. Again, change from soft to medium steel may affect not only working stresses but indirectly many accepted rules, such as those that involve buckling tendencies or ability to withstand mechanical abuse.

Common sense thus leads to modifying many rules of design. However, as Mr. Woodruff pointed out, extensive experience is crystallized in many empirical rules, and therefore the practical consequences of any innovation should be thoroughly weighed, or serious results may follow, as in the instance of adopting tempered wire for the Mount Hope and Detroit suspension-bridge cables.

Building design involves a large range of indeterminates and variables that require the use of common sense, according to Mr. Smith. Underestimate of dead load and failure to study foundation conditions, with the combined result of producing settlement, are a common instance of failure to use such engineering sense. Another is the occurrence of wall cracks from failure to coordinate the masons' work with the compression of the frame. As to faulty load estimation, Mr. Smith remarked that it is not common sense for the engineer to fool himself. A specific case of prevailing false practice is found in wind-stress calculations. One can hardly doubt, he said, that 100-mile velocities may occur in most regions, or that such velocities produce pressures of the order of 40-lb. per sq.ft. Allowance for shelter is proper, but should in no case be applied to towers. It is far better to use the full possible load at high units than to use artificially low loads at conventional unit stresses.

Mr. Smith then outlined a method of procedure for wind design of building frames. He further insisted on the need for a well-developed sense of proportions to supplement analytical knowledge. He paid his respects to the tonnage basis of fixing fees for engineering design of building frames, and said that correction of this faulty condition depends on education of owners and architects.

Allston Dana, engineer of design for the Port of New York Authority, laid further emphasis on the importance of detailing, and asserted that here originality and good judgment have their widest opportunity. Such facts as those of stress relief in the outer rivets of moment groups, or in the outer fibers of pins (but not I-beams), or in eyebar heads, must be utilized understandingly; attempts at precise analysis here would in general be misleading. Jonathan Jones, chief engineer of McClintic-Marshall Co., Bethlehem, referred to the important function of common sense in appraising the true action of a suspension-bridge stiffening truss, through which understanding, notably in the design of the Camden bridge, economy and efficiency of construction were greatly promoted. Frank Randall, structural engineer, Chicago, cited various examples of good and bad sense in structural design, and challenged the value of design refinement in reinforced concrete when the work is later executed under conditions of great variability.

A final report was presented by the committee on reinforced-concrete arches, and a progress report was submitted by the committee on masonry and concrete. The latter has been organized in a number of active subcommittees, dealing separately with slabs, columns, plastic flow and various other elements of behavior of the material or the structure.

The concrete-arch committee, in its commendably brief final report, presented a number of conclusions. The more general ones are: that elastic analysis on the basis of the usual assumptions of flexure is adequate for design; that the rib concrete has about the same strength as 6x12-in. test cylinders, that time yield and other causes may induce a rib shortening of as much as 1/1000 in the first six months, but that the resulting stresses are largely eliminated by plastic flow, and that design should allow for a length change of 2 to 3 ten-thousandths; and that time yield of foundation soil may be a source of serious pier tipping unless uniform load distribution is obtained. Other conclusions relate to deck participation, but apparently the committee is not able to indicate under what conditions deck participation is important.

This committee's work is noteworthy for being based on a remarkably extensive range of experimental work on full-sized bridges, on laboratory structures and on models.

Sanitary engineering

With two half-day sessions available, in contrast with one such session at previous meetings, and with a high degree of interest displayed in the technical proceedings, the sanitary engineering division had a most successful meeting. In large measure the meeting extended and carried forward the discussion of the technical aspects of sewage treatment which had been given attention at the meeting two days earlier of the New York State Sewage Works Association.

The meeting opened with the presentation of a paper entitled "Sanitary Engineering Experiences in the Operation of a Large Industrial Enterprise," by A. Clinton Decker, sanitary engineer of the Tennessee Coal, Iron & Railroad Co. This company is the largest industrial enterprise in Jefferson County, Ala., in which the city of Birmingham is situated. The numerous properties of the company and the diversity of their operations, combined with the large number of employees, bring about a great number of problems in sanitation, and the company for some years has employed a full-time sanitary engineer. Mr. Decker's paper was devoted largely to outlining the types of work done by the sanitary engineer of the company and appraising the accomplishments thereof.

Much of the work has been done in cooperation with the office of the sanitary engineer of Jefferson County. Included among the examples of the larger county projects in which this cooperation was of great service were the sewage-disposal program of the county and the new industrial water supply for the city of Birmingham.

In discussion, W. A. Hardenbergh, of *Public Works,* formerly sanitary engineer of Jefferson County, described the great strides that have been made in sanitation there during the past twenty years. The active cooperation of the industries of the region with the health officials, he said, has been of tremendous value in improving the county's health condition.

New York's sewage problem

The sewage-disposal problem of the New York region was given extensive discussion at the meeting. The status of the city's sewage-disposal program was described by Richard H. Gould, of the department of sanitation. Mr. Gould outlined briefly the history of former official bodies responsible for sewage disposal and recalled the creation of the present department of sanitation at the end of 1929. This department now has the responsibility for the design, construction and operation of intercepting sewers and sewage-treatment plants throughout the entire city.

There are at present sixteen plants in the city giving some degree of treatment to the sewage, although many of them are old, somewhat obsolete and almost inoperative. Of the sixteen plants, eight give treatment by fine screening only, six combine coarse screening and a certain amount of sedimentation, and two are equipped with coarse screens only.

The Wards Island activated-sludge plant, which will take the sewage from a large area of upper Manhattan and the Bronx, is nearly completed. Plans have been drawn and bids will soon be asked on the construction of a chemical-precipitation plant to be located near Coney Island. A third plant is now being planned for the Jamaica Bay region.

In his discussion of Mr. Gould's paper, Samuel A. Greeley remarked that unlike most communities, which have but a single sewage-disposal problem, New York is faced with what might be considered 38 different undertakings. To solve the problem as a whole, there are two general objectives to be met. First, there is the necessity of meeting the local needs of the various districts of the city contributing pollution to the harbor and being affected thereby; and second, there is the necessity of coordinating the individual relief measures adopted so that the harbor as a whole can be properly benefited.

The preliminary treatment of sewage for the removal of grease and oil, a consideration now receiving considerable attention, was given discussion by Harrison P. Eddy, Jr. Mr. Eddy cited figures obtained from sixteen different Massachusetts cities, which showed that the amount of ether-soluble material in sewage had an average value of 53 p.p.m., equal to 28 per cent of the suspended solids.

Two general methods of separating oil and grease from sewage were noted. One method involves the use of special tanks for the purpose, while the other accomplishes the removal in the regular sedimentation tank. Of the special tanks, the type that has been given most attention relies to a large degree on aeration for its operation. These tanks usually give but a short period of aeration, and the oil and grease that are raised to the surface pass behind baffles and are then removed.

It has been noted that but a small amount of the total ether-soluble matter in the sewage is removed by these special processes. From experiences in Cleveland, George B. Gascoigne concluded that only about one-third removal can be expected, and of the amount removed only a small part is skimmed from the surface, the rest of the removal being accomplished by sedimentation and taken out with the sludge.

A spray-drying method of dewatering sewage sludge was described in detail by C. L. Riley. This process involves the use of special equipment for atomizing the sludge into a chamber through which a blast of hot air is passed. A pilot installation has been in operation at Plainfield, N. J., for some months. Mr. Riley developed the mechanical and thermal aspects of the problem in his discussion and demonstrated that the amount of fuel required to evaporate the moisture in the spray decreased disproportionately as the amount of moisture in the sludge was reduced just prior to spraying.

The present status of chemical treatment of sewage and the outlook for it were topics presented by Linn H. Enslow. Mr. Enslow predicted the increasing popularity of chemical methods of treatment accompanied by a greater familiarity with the proper operating technique. Although chemical methods had a great vogue many years ago and then lost their popularity, they are faced with a far more favorable situation today because of developments in the methods available for handling sludge and the improved knowledge that sanitary engineers now have of the coagulation and flocculation processes. In the earlier days of chemical treatment, it was not unusual for the chemicals used to increase the amount of sludge produced by 100 per cent, while it has been demonstrated at the Shades Valley plant at Birmingham, Ala., that proper control of flocculation, together with the return of sludge to the incoming sewage, will yield an amount of sludge only about 10 per cent greater than the amount of sewage solids removed.

The only detailed attention given at the meeting to the subject of water-supply engineering was given to the report of the committees on filtering materials and on water-supply engineering. The filtering materials report was presented by W. E. Stanley and was followed by a detailed description by James W. Armstrong of the experimental work carried on by the committee in connection with filter sand. A great mass of data has been compiled by the committee indicating the desirability of using coarser sands for more efficient operation. Mr. Armstrong also presented a method of designing a filter bed when the characteristics of the sand available are given.

Highways and construction

The highway and construction divisions held a joint technical session, at which four unusually excellent papers were presented, all bearing on highway safety.

In a paper on highway designs and travel speeds, E. C. Lawton, assistant commissioner of construction, New York state highway department, laid emphasis on the importance of sight distance in the design of safe roads. Though statistics show, according to Mr. Lawton, that only five per cent of highway accidents are due to faulty road design, he declared that the highway designer holds the destiny of more people in his hand than any other person, and he pleaded for unceasing study of safer road construction by trained and competent engineers.

Mr. Lawton listed four prime factors affecting the safety of roads: sight distance, alignment, grades and traffic control. Though a sight distance of 600 ft. often is considered as adequate, Mr. Lawton said that with two cars approaching each other at 40 m.p.h. and a third overtaking one at 48 m.p.h., studies show that a sight distance of 2,000 ft. is required for a safe passing.

Mr. Lawton regards three lanes as undesirable because of the common use of the third or middle lane, a potential accident hazard, but admits the three-lane road is required on many miles of route where a four-lane width cannot be justified on economic grounds. The three-lane road requires a greater sight distance for safe driving than does the two-lane or four-lane highway. On primary routes New York sets a minimum sight distance of 800 to 1,000 ft. for three-lane routes and 400 ft. as a minimum on four-lane roads. On secondary roads 500 ft. is regarded as the minimum sight distance.

In New York, curve-widening and banking are based on the combined judgment of experienced designers and construction engineers, rather than on theoretical formulas. On primary routes curves are limited to 1,500-ft. radius, with 2,500 ft. set as standard. On secondary routes 1,000 ft. is regarded as a minimum, with 1,500 ft. as standard.

The speaker warned against improper design of auxiliary structures of the highway, such as grade-crossing eliminations, islands, circles, etc., which, if not designed and built properly, constitute a greater accident hazard than conditions existing prior to their construction.

Separation of ways

Absence of engineering technique is largely responsible for the chaotic condition popularly known as the "grade crossing problem," according to Robert H. Ford, assistant chief engineer, Rock Island Lines, who presented a paper on separation of ways. He declared that the situation is so aggravated that it becomes both a challenge and an opportunity for the engineering profession. Resourceful leadership is needed, combined with engineering technique and an understanding of the economics of transportation. The public, Mr. Ford said, has a right to expect some crystallization of technical thought and acceptable pronouncements from leading professional and scientific organizations as an aid in the formulation of legislative and administrative enactment. The root of much of the difficulty lies with the legislation that is out of step with requirements of modern transportation methods.

Mr. Ford pointed out that there are, roughly estimated, 235,827 grade-crossings in the country, of which 60,000 are wholly unnecessary, 45,827 require only minor action, 100,000 require protection, and 30,000 must be separated. The railroads are without funds, and are unlikely ever to have sufficient funds for even a small part of the cost of necessary separations. The savings in cost of operation to the railroads through grade-crossing eliminations, he said, has been greatly overestimated in the past.

Uniform traffic code

In a paper by A. B. Barber, U. S. Chamber of Commerce, read by E. W. James, the status of the uniform traffic code was discussed in its relation to highway safety. The original draft of the code was prepared in 1926, revised in 1930 and again in 1934. In ten years 35 states have adopted one or more of its provisions or have harmonized local codes to its general provisions. With many state legislatures now in session or to meet soon, the prospects of further adoption of the uniform code are bright. The paper pointed out that licensing of drivers is being adopted by an increasing number of states. The accident records of licensed-driver states is improving, according to Mr. Barber, while that of non-licensing states is not. This was disputed in a discussion by Prof. W. J. Cox, of Yale, who declared that rural accidents in both classes of states are increasing at a terrific rate, while urban accidents are dropping below the rate of increase in registrations.

Letters to the Editor

Cape Cod Canal Bridges

Sir—In your interesting description of the foundation work for the new Cape Cod Canal bridges (*ENR*, Jan. 3, p. 1), there is a statement that appears to need modification. You say: "What was not known and was only revealed by the foundation operations was the variable amount of boulders at different locations and different depths, the relatively large size of many of the boulders, etc." It seems hardly possible that these facts can have been forgotten in 25 years, for they were amply revealed during the period of original construction, from 1909 to 1914. Although many wash borings were made at various times during the previous 30 years (including a numerous and well-distributed series throughout the entire line made in 1908), such borings give no positive information as to the size or extent of boulders, although the fact that the depth of sinking the pipe casing was usually limited by some positive obstruction before any great depth was reached was a fairly good indication of the frequent presence of boulders.

But the work of excavation, and particularly that for the bridge foundations, showed very clearly the extremely variable size, distribution and quality of boulders encountered.

In excavating for the piers of the railroad bridge at Buzzards Bay in the winter of 1909-1910, a floating dipper dredge dug to about 40 ft. below mean sea level and removed many boulders, including one estimated to be 80 cu.yd., which had to be blasted under water before removal. When excavation was completed, wooden bearing piles were driven, closely spaced through the pier area, and accurately cut off to receive a timber grillage forming the bottom of a floating cofferdam within which the masonry pier was constructed and finally sunk on the supporting piles. In driving these, it was found impossible to reach depths exceeding 15 or 20 ft. under the north piers because of the mass of boulders. The railroad bridge was built between November, 1909, and September, 1910. I am not positive whether a clamshell dredge was used in the final work of excavations for the foundations, and it is possible the piles were cut off a little higher than 40 ft. below mean sea level, but not higher than 35 below. These details are not among my personal records, but the fact remains that nests of boulders were encountered immediately alongside the present work.

Certainly no one who worked on this bridge would have assumed that he could drive sheetpiling in the immediate vicinity and strike boulders only in 10 per cent of the work.

The same contractor subsequently built the foundations for the highway bridge at Bourne, three-quarters of a mile eastward, and, on the basis of his experience at Buzzards Bay, elected to use pneumatic caissons. Under none of the piers were boulders encountered.

Henry Welles Durham,
Sandwich, Mass., Jan. 8, 1935.
Formerly Resident Engineer, Cape Cod Canal.

Rolling Bituminous Roads

Sir—The interview with Professor Crandell, appearing in your issue of Nov. 22, 1934, p. 658, is so much at variance with the well-balanced articles usually appearing in your paper that we believe it is advisable to call your attention to one or two points in connection with it.

In answer to the question "What progress has been made in mechanical mixers and spreaders?" Professor Crandell says at one place, "The jerky, badly handled roller must be superseded by a modern type, and operators must be educated to run them."

Improved rollers were designed and placed on the market several years ago for the very reason that the market did not then afford a roller capable of the smooth performance required on bituminous types of paving. Ironer rolls were added which, together with the front roll, form a long plane, much longer than the average wheel base of automotive equipment, and when used on bituminous pavements not only compact them uniformly but produce a smooth-riding surface comparable with modern concrete and brick, stated by Professor Crandell to be necessary.

A little later, however, in this same answer Professor Crandell says: "The retread type of road has shown most decidedly that traffic itself irons out a bituminous road to the smoothest surface obtainable. It is a mistake to roll such a road if a reasonable amount of traffic comes on it soon after it is built."

It is our opinion that this fallacy has retarded the progress of bituminous roads in this country more than any other cause. Failure to insist on proper compaction of bituminous paving by modern road rollers has cost more than one producer of asphalt and bituminous materials subsequent orders where their material has been used on an initial project and, due to the lack of proper compaction, the new piece of road, on which so much depended for the manufacturer of the bituminous material, soon went to pieces. Bituminous types of paving to give satisfaction and maximum length of service should be properly compacted, and the material should be keyed by means of a modern road roller. It stands to reason that traffic will not compact the surface as satisfactorily as a roller, because the point of contact of vehicles composing traffic is a narrow wheel as compared with the broad rolls used on the modern road roller, which contact the entire surface of the road for a strip about 6 ft. wide each time they move.

I do not think that the people who have had to use some of these traffic-bound bituminous roads, and who have had the paint finish of their cars marred by being spattered with this loose material, would share Professor Crandell's views. A modern roller not only prevents trouble from this source but enables a road to be used for traffic at a reasonable speed much sooner than the traffic-bound method. To leave roads to traffic to bind them is distinctly a step backward, and it is hardly consistent to urge more modern development of machinery and equipment for this type of highway and in the same breath suggest a method of compaction to eliminate equipment altogether.

There are a number of other items in Professor Crandell's interview which do not stand up under analysis, which is to be regretted. The field of bituminous paving is being done untold damage by loose thinking, loose statements and poor engineering practices.

G. V. R. Mulligan.
Merrion, Ohio, December 3, 1934.
Manager, Road Roller Sales, The Hercules Co.

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Not For Recovery

IN ITS FIRST DRAFT, the new construction bill submitted to the House of Representatives realizes the worst fears of those who apprehended that an unsound and dangerous program might be put forward. In this bill the Administration proposes to carry out a pure work-relief campaign, apparently through a revamped CWA system. The stated purposes of the measure all center on relief; they leave no question that it is directed solely toward "welfare" ends and is not intended to serve recovery purposes. Detail is absent, beyond broad authorizing clauses; the bill is a blank check to the President's order. But White House statements of a few days ago suggest that the intention is to operate the program on a force-account plan and recruit its workers from the relief lists. That such a program will work extensive havoc, that it will deal a crushing blow to the construction industry, that it will retard and not promote recovery and growth of confidence, is too well known to all familiar with construction to require emphasis. But through their Congressional representatives their knowledge may still be brought to bear on the plan, to the end of reconstituting it as a recovery measure.

Strong Technical Life

REFRESHING VIGOR of technical thought and interest was revealed by the character of the Civil Engineers' meeting last week. The sessions had large attendance and strong programs, and visibly held the interest of their constituencies throughout. They showed that the technical divisions have effectively taken over the work of the society, for the meeting in effect was a congress of independent societies rather than a single meeting. The themes of discussion were generally of desirably limited scope, giving well-proportioned representation to current problems of engineering and construction. The research spirit was prominent, and a noteworthy seriousness of purpose marked all proceedings. It is no derogation to the meetings of past years to rank this one among the strongest in the society's recent history. It testified to the fact that civil engineering, one of the greatest sufferers from the stunning impact of the depression, is overcoming its shell-shock and is turning resolutely to the task of working out its technical assignment. This demonstration of the profession's vitality and recuperative power also brings anew to mind that the society is rooted in the soil of technical activity and study. Deprived of the sustenance it draws therefrom it would be sure to perish.

Efforts Bearing Fruit

CONSISTENT EFFORT of the general contractor's code authority to sell the construction code to the contracting fraternity appears to be bearing fruit. On a code-popularization tour of the West, it is reported, members of the authority everywhere found a large and interested audience. At the same time contract registrations under the code have held up well, despite the winter season. These facts are significant. They mean that contractors are interested in the code, and are anxious to get an understanding of its intent and purposes and the difficulties of administration. Most contractors are not in favor of the code as it now stands, but if they can be shown that it is their own code and that they are bound by it, their unfavorable attitude can usually be changed to acceptance. The volume of registrations indicates that there is much more determination to support the code than has seemed to be the case. While the code is being perfected by revision and amendment, those affected by its operation still need to be informed and convinced. Now that the first real effort to this purpose yields encouraging results, there is hope for continued effort and full success.

Progress in Swamp Fills

PROGRESS in fitting available means to the requirements in carrying road embankments across swamps is exemplified by the description in this issue of Michigan construction practice. Basing the selection on a determination of swamp conditions, the Michigan engineers use straight excavation, blasting, liquefying, soil selection and surcharging in such combination as best meets the conditions. The result is a degree of certainty of procedure and outcome that did not prevail when faith was pinned to a single device or method. It is logical that no one construction process should be effective for all swamp soil conditions and depths; a few years ago, however, single panaceas were rather popular, and much pride was taken in standardizing their application. Swamp fills have been a trouble to railway and road engineers and to levee builders for too long a time to justify belief in a simple remedy, and this view is supported by the teachings of the newer soil physics, which make it clear that all fill materials, especially in swamp-embankment construction, do not behave alike. Acceptance of this fact is the foundation of the new practices described in this issue.

In Praise of Engineering Sense

EVER SINCE the art of the civil engineer evolved from craft skill and resourcefulness in putting the earth's materials together to form useful structures, engineering has relied on a special union of measurement, calculation and judgment. Though from time to time, because of progressive improvement in measuring and calculating ability, the importance of judgment tends to be undervalued, it nevertheless remains the indispensable basic ingredient. Engineering sense, product of cumulative weighing of experiences, is equally decisive in project location and proportioning, in general design and in detail development, however much physical measurement and mathematical analysis may advance. An illuminating restatement of this truth was made by the discussion of common sense in structural design at the Civil Engineers' meeting last week. The several speakers brought out in typical illustration that even highly refined analysis is, after all, only an auxiliary to judgment, that formal rules and procedure may tend to lead away from good engineering rather than promote it, and that detail design must refer to the judgment of good engineering sense at every point. A sense of proportion, a sense of fitness, a sense of efficiency and economy, are individual phases of the broader engineering perception that is developed from careful study of experience. It is the engineer's one indispensable item of equipment. The discussion cited performed a timely service in reaffirming its importance.

Clearing Views on Arch Bridges

In All Probability the ten years' work of the ASCE research committee on concrete arches, now brought to an end by its final report, contributes more to knowledge of this fundamental structural element than was learned in the three millennia since the arch was first conceived. A prodigious amount of well-directed labor is represented in the observations on actual arch bridges and models and the laboratory studies carried out by the committee—a remarkably concentrated and effective attack on an important problem. The full range of results cannot be appraised until the report is published in its entirety, but even the brief summary that was laid before the meeting last week shows that extensive clearing of views on concrete arch bridges has been accomplished. Most important is the conclusion drawn from the tests that the accepted elastic analysis is adequate for open-spandrel arches without continuous superstructure, and that test-cylinder strength may be expected in the rib concrete. Other significant deductions are that neglect of care in foundation design may seriously affect the strength of an arch, and that the hazard of length change due to shrinkage and yield is quite limited, a shortening of 1:4000 being about all that need be looked for. On the matter of the interesting complication produced by deck participation through the stiffening effect of deck and columns on the rib, no simple findings have emerged, so far as the summary indicates. For the present, subject to what the full report may bring out, it seems a safe conclusion that deck participation is best avoided, as it makes the arch rigid and so to say brittle with respect to many vicissitudes of its service life. The engineer in considering whether to make his spandrel columns and deck continuous with the rib may well bear in mind the old saying, "The arch never sleeps."

An Inventory of Water Resources

EXAMINATION of the just-published report of the water resources section of the National Resources Board confirms the impression gathered from the earlier report of the board itself, to the effect that in water resources lies the primary problem of the study of national development. What the present report brings out is of far-reaching value. If anything were needed to emphasize the many intimate relations between water and human life and welfare, the facts contained in the present report would amply do so. They establish water study as preeminently the most important single study of our national possessions, a study for which the stock-taking of water resources and water uses which forms the principal part of the report lays a secure foundation.

An inventory of fixed assets, as land and mineral resources, is in the main a one-time job, for only slow change affects such possessions. Water, on the other hand, is a constantly changing quantity, and only continued observation and study of factual data can express it correctly. From rainfall distribution and storm frequency to the yield of wells and the degree of pollution of streams, an extensive range of variables needs to be observed and analyzed if man's use of the vital element is to be safeguarded and made efficient. A great many agencies, state, federal and local, have long been engaged in gathering water data, but their largely uncoordinated work has never been brought together into a single comprehensive aggregate comparable to that furnished by the present report. With an inventory now made available, a necessary first step has been made toward continuing study of the nation's water assets.

The results of the inventory throughout focus attention on the gross lack of coordination in water study. The many agencies active in this field do not agree as to method of procedure and have no means of bringing their results together in a comprehensive, consistent collection. In the federal government, for example, rainfall is observed by the Weather Bureau, stream stages by the Engineer Corps, groundwater levels and river discharges by the Geological Survey, tides and currents by the Coast Survey and the Lake Survey, while water quality and pollution, where studied at all, receive casual attention by such agencies as the Public Health Service and the Reclamation Bureau. Almost equal diversity exists in state and local collection of information on runoff, flood and drought conditions, amount and character of water supplies, and the like. The methods of these different agencies are not in agreement; frequently different annual periods are used, and in some cases even the observations of a single group, as Weather Bureau observations, do not all relate to the same time of day. A more chaotic condition of vitally important data could not well be conceived.

A number of recent experiences make it clear that the actual responsibility for problems connected with water use and protection is ever more definitely being assigned to the federal government by private land owners, local governments and states directly concerned. Irrigation development was made a federal responsibility more than thirty years ago. Demand for federal action to control floods has been insistent since the Mississippi project was begun in 1928. The effects of the 1930-31 drought and that of last year were so severe as to lead to general requests that the federal government lend its aid, and the government did, in consequence, expend many millions in drought relief. Every major water problem arising nowadays similarly finds its ultimate resting place in the lap of the national government. It is not difficult to judge from this course of evolution that in spite of legal and popular doctrine on local control of water there is a steady and irresistible trend toward recognizing that water is a national resource and in due course must become subject to national control.

With federal responsibility toward water thus rapidly growing, and with factual study of water resources in a scattered and uncoordinated condition, the time has come when a well-centered and coordinated agency of water study is essential to continuing progress. The work of the National Resources Board in assembling a basic record of fact makes apparent the immediate necessity of some centralization of this kind, for without it there can be no continuity in collecting and analyzing observation data, and the present inventory must soon suffer depreciation through obsolescence. Should the report of the Water Resources Section perform no other service than to be the means of bringing about this reform of governmental organization and action, it would stand as an accomplishment of lasting value to the whole nation.

CURRENT NEWS

Work Relief Bill for $4,000,000,000 Before the House

(Washington Correspondence)

THE administration's bill, providing for the expenditure of $4,880,000,000, introduced in the House Jan. 21, contains provisions which would grant wide powers to the President for handling this fund, for the reorganization of federal agencies, the extension of the life of various emergency units and the development of new plans for work projects. Republican members of the House would like to place some restriction on the centralized authority, if they were able. Concerted attempts to earmark specific projects and to restrict the general powers of the measure by clear-cut definitions are anticipated when the measure reaches the Senate.

Features of the bill

Although adhering closely to the President's message of Jan. 4, in its work features, the bill contains some surprises. It specifically refers to slum clearance, rural housing, rural electrification, reforestation, soil erosion, blighted area and submarginal land reclamation, improvement of existing road systems and construction of national highways, grade crossing elimination, CCC work, and "other useful federal or non-federal work." It goes far in giving the President broad authority to reshuffle federal agencies.

Postponement of the termination of any existing agency to June 30, 1937, presumably would extend the life of NRA, due to expire next June, even if a separate measure is not enacted. The President may utilize and prescribe the functions of any government agency, including a corporation; may consolidate, redistribute, abolish, or transfer functions; and may delegate these powers to any government agency.

Funds under the bill are made available immediately rather than waiting until after June 30 to tap the $4,000,000,000 lump sum asked in the budget. In addition, $880,000,000 of unexpended balances from past appropriations is made available.

Types of work

Broad objectives of the measure are "to protect and to promote the general welfare by: (1) providing relief from the hardships attributable to wide-spread unemployment and conditions resulting therefrom, (2) relieving economic maladjustments, (3) alleviating distress and/or (4) improving living and working conditions, * * *."

The President is empowered to guarantee loans to, or payments of, needy individuals, which could include extension of the HOLC. He may make grants, loans, and contracts and may purchase

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Steel Bids on Muskingum Project Are Identical for 33 Bidders

Identical bids were received from 33 manufacturers and distributors at the opening of bids for 2,030,000 lb. of reinforcing and other steel to be used in five dams to be constructed by the U. S. Engineers as part of the Muskingum Valley Conservancy project. The bids were opened Jan. 9. Figures were based on code prices. It was subsequently announced that each bid will be recorded on a card, and a separate drawing will be made for the 26 bid items, embracing 13 sizes and two grades of steel, with chance determining the successful bidder for each item on the schedule.

Financial Report Issued by RFC Shows Construction Loan Volume

Self-liquidating construction loans, authorized by the RFC, up to the end of 1934, totaled $258,227,000, according to the financial report of the Reconstruction Finance Corporation, just released. Disbursements for this type of construction loan totaled $131,715,000.

The report showed that about $29,000,000 of securities held by the PWA had been sold by the RFC. Some of the major items contained in the report were:

Loans Outstanding	$1,546,198,710
Stocks and Notes of Banks and Insurance Companies	846,059,742
Advances for Relief	297,773,590
Allotments to Other Governmental Agencies	1,689,226,245
Total Assets	4,432,627,131
Earnings	65,175,963

Denver Concludes Contract for $3,500,000 Water Project

With the final signature of Administrator Ickes closing the negotiations for a $3,500,000 PWA allotment to the City of Denver for completion of its Fraser River water diversion project, construction work will be started at once. Negotiations began in October, 1933, and the principal problem, which resulted in the long delay, resulted from the question of financing and repayment to the PWA.

The general features of this water supply project were reviewed in *ENR*, Dec. 6, 1934, p. 730.

Ohio Relief Work Includes Dams

A program of small lake and conservation reservoirs has been announced as part of the program of the Ohio State Relief Commission. The projects would be for flood control and water conservation use, and would involve an aggregate expenditure of $3,633,000. Already, tentatively approved projects in this program total $97,000.

Casper-Alcova Irrigation Project Held Legally Unsafe

COMPLICATIONS over the water rights on the North Platte River in Wyoming and Nebraska, which affect the Casper-Alcova irrigation project now under construction by the Bureau of Reclamation, have culminated in an opinion by Nathan R. Margold, solicitor for the Department of the Interior, that the federal government cannot safely proceed with the project. The Seminoe unit of the project, which comprises a power development in Granite Canyon, is not affected by the decision. Specifically, Solicitor Margold held that the permit to cover the appropriation of water for the project through the proposed Casper Canal, by the federal agency, was not issued by the state engineer of Wyoming in consonance with the law.

The opinion was contained in a letter addressed to Secretary Ickes on Jan. 17, which was in answer to a request for the opinion of the solicitor on "the legal questions involved in a determination of the priority rights which would attach to a projected, and now conditionally approved, appropriation of water by the United States from the North Platte River in Wyoming through the proposed Casper Canal."

History reviewed

In 1904 the U. S. Reclamation Service planned the construction of the Casper Canal as part of a development along the North Platte River, and on Dec. 6, 1904, a permit for the desired appropriation was filed with the state engineer of Wyoming. For nearly 30 years no action was taken with reference to this application, either by the state or by the United States. The letter states that "There is some evidence tending to show that the government failed to request action upon its application, because the Reclamation Service doubted the feasibility of the project."

During the following years many persons perfected rights to the waters of the North Platte River, both above and below the Pathfinder Reservoir.

On July 5, 1934, the state engineer returned the 1904 application for correction, and for redraft, in accordance with present laws and regulations. On July 26 the application was resubmitted in amended form. Aside from being amended in form, the new application differs substantially from the original, in designating entirely different land for irrigation, increasing the area to be irrigated from 25,228 acres to 82,000 acres and changing the point of diversion. Further, the amended application is for an appropriation of 12,000 sec.ft., while the original covered an appropriation of only 300 sec.ft.

State action

On Sept. 14, 1934, the state engineer allowed the amended application and issued the necessary permit authorizing the con-

(Continued on p. 143)

IN WASHINGTON

By Paul Wooton
Washington Correspondent

While Congress is certain not to override the recommendation of the President and increase the $4,000,000,000 relief fund, many members think the authorization should be for enough to take care of all unemployment, even if it should be necessary to go to a lower wage rate than now contemplated.

A thoroughgoing study of rural electrification just has been completed by a subcommittee of the National Power Policy Committee. T. W. Norcross, of the Forest Service, is chairman of the subcommittee. The report will not be made public until it has been considered by the full committee.

The Administration will not be in a position, until after careful surveys are made, to make even approximate allocations of the $4,000,000,000 work relief fund. The President has emphasized personally that he wants complete flexibility so as to award allotments to the projects that show greatest promise of producing employment. Congress, however, is likely to do some earmarking of its own.

Subordination of the banking point of view to the practical business point of view is the real significance of the new policy of the Federal Reserve Board in specifying that business men and industrialists are to be in the majority.

President Roosevelt has reiterated his conviction that force account should be used on all work relief projects. When asked about highways and bridges he said a superintendent of the contractor type could be chosen who would draw his labor from relief rolls.

A partial report by the Federal Power Commission on the rate survey will be submitted to Congress Jan. 31. This particular report will cover, as of Jan. 1, rates in cities of 50,000 and over. All rates have been reduced to a comparable basis. Rate reductions since July 1, 1934, will be shown.

Action of the Supreme Court of the United States in granting the government permission to file an original suit against the state of West Virginia greatly expedites the settlement of the fundamental issues involved in the Electro-metallurgical Company's Hawks Nest project on New River. The suit goes to the heart of the authority of the Federal Government over both navigable and non-navigable streams.

Amendments to the water power act which will provide for federal regulation of interstate movements of power are still under study at the Federal Power Commission.

Wisconsin Engineering Students To Get Course in Economics

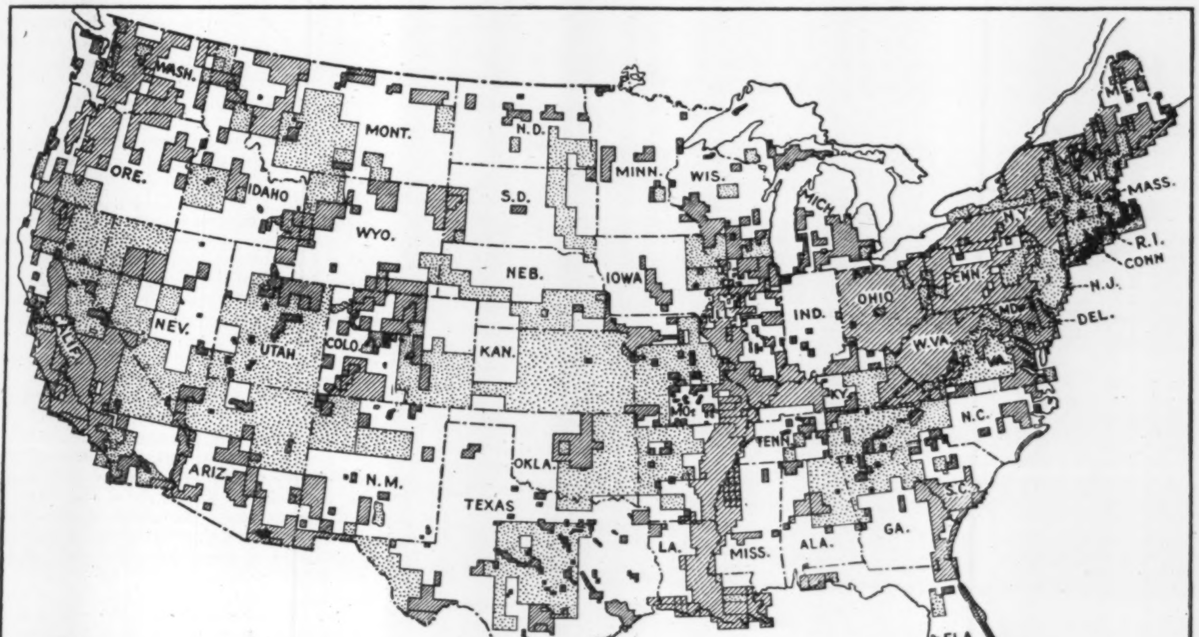
A course in "Current Economic Problems" has been arranged by the College of Mechanics and Engineering of the University of Wisconsin under the direction of Dean F. E. Turneaure, for senior engineering students. The course will be given the first time in the current spring semester. The prerequisite for the course will be senior standing in the college of engineering.

Subjects covered

Some of the typical lecture subjects in the course are: "The Present Economic Situation," "Deflation, Inflation and Recovery," "The Problem of the Unemployed," "National Resources and National Prosperity," "A Coordinated Transportation System," "Balancing the Federal Budget" and "The American Crime Problem."

The instituting of the present course follows a special course of lectures given at the University of Wisconsin's summer session in 1934, which was so favorably received as to indicate the desirability for presenting this type of course to the senior engineering students. The course is designed primarily to assist the students in planning subsequent studies of economic problems rather than presenting detailed economic treatment of the subjects.

ADEQUATE TOPOGRAPHIC MAPPING COVERS ONLY 25 PER CENT OF THE COUNTRY



With only 26 per cent of the United States covered by adequate topographic maps, the report of the Board of Surveys and Maps to the National Resources Board has recommended a program of mapping requiring an expenditure of $170,531, over a ten-year period.

In addition to the 810,000 square miles (26 per cent) adequately mapped, about 740,000 square miles (24 per cent) was mapped more than 40 years ago and is inadequate for present needs, and about 1,500,000 square miles remain entirely unmapped.

This condition is indicated in the accompanying map showing the progress of topographic map coverage. The report of the Board of Surveys and Maps which was made public January 14, was abstracted, as to recommendations for the proposed 10-year program, last week on page 108.

National Inventory Of Water Resources Offered By Committee

FEDERAL participation with the states in carrying out a unified policy with regard to the control and development of the water resources of the country is urged by the Water Planning Committee in its report to the National Resources Board, made public on January 18.

To accomplish the major objectives of the nation in regard to water, which include the development of more productive uses, and the correction of conditions resulting from the harmful effects or abuses of water resources, the committee recommends that five different lines of action be undertaken, as follows:

1. Furtherance of surveys, inventories and records of conditions fundamental to the use and control of water resources;
2. Study of the federal and state legislation needed to bring about cooperation between the various governmental agencies;
3. Studies and experiments in directive and administrative planning in selected unit areas;
4. Detailed study of representative projects on a drainage area basis, similar to the study given the Tennessee Valley;
5. The creation of an advisory planning agency for coordinating the use and control of water resources.

The factual foundation for the committee's recommendation is presented by an inventory of the water resources of the nation. This inventory assembles hydrologic and physiographic data from many sources, and, in addition, presents much original material The topics covered in the inventory include precipitation, surface waters, ground waters, quality of surface and ground waters, coastal erosion and protection, the drought of 1934, flood control, public water supplies, waste disposal and water disposal, drainage, irrigation, recreation, hydro-electric power, ports and terminals and surface and ground water storage for conservation.

An extended abstract of this section of the water committee's report will be published in *Engineering News-Record* in an early issue.

The water planning committee comprises Morris L. Cooke, chairman, Harlan H. Barrows, Herbert S. Crocker, Col. Glen E. Edgerton, Henry S. Graves, Major-Gen. E. M. Markham, Charles H. Paul, Harlow S. Person and Sherman M. Woodward. The inventory of water resources was prepared under the direction of Thorndike Saville, professor of sanitary engineering at New York University, who acted as executive engineer for the committee.

Bonds for Golden Gate Bridge Sold in Open Market at Premium

Golden Gate Bridge & Highway District bonds to the amount of $3,200,000 were sold in San Francisco on Jan. 16 at an average price of $102.65728. This price is 10 per cent higher than the price paid when the district made its initial offering of bonds about two years ago. The larger portion of the offering matures at dates ranging from 1942 to 1971.

Hearing on Code Wages To Be Held by NRA

A representative of the Construction Code Authority will make a presentation at the public hearing which NRA has slated for Jan. 30 relative to employment provisions of the various codes. A comprehensive program has been announced for this hearing which is expected to last for several days. The NRA desires information as to whether limitation of hours has affected the volume of employment and the hourly, weekly and annual earnings, as well as its effect upon the cost of production. It inquires as to the effects of minimum wages and wage differentials based on location or population. It desires to know how effective the wage and hour provisions have been in eliminating unfair competition.

NRA sets forth the present position of the National Recovery Board in seven items as the basis for the hearing. It maintains that a minimum wage structure is socially beneficial not only as a safeguard to the worker, but also as a wage floor for the operation of the competitive system; however, it is important to determine the effect which inequities in wages above the minimum have upon competitive conditions. It cites geographic, population and other wage differentials as concomitants of the industrial development to be treated as significant realities of the present situation; that the principle of limitation of hours should be upheld since maximum hours of employment have made a definite contribution to re-employment. It holds, however, that greater simplicity, flexibility and uniformity are possible and desirable with respect to hour and wage provisions. It contends that general labor provisions, such as those dealing with safety and health, apprenticeship, handicapped persons and stabilization of employment, contribute to the welfare of the worker and to fair competition so as to justify their continuance in one form or another; and finally, that an increased volume of production is now the most important means of securing re-employment, and it will welcome appropriate suggestions for the stimulation of volume.

Survey of Highway Work Made for Coming Program

A definite program of possible highway projects, with estimates of cost, has been prepared by the American Association of State Highway Officials through direct queries to state highway departments throughout the country to determine the additional work of all types which can be done under the President's new work program. Main highway projects, secondary roads, grade crossing eliminations, bridges, culverts, city work, bypassing cities and main highways, and other features are covered in detail state by state.

The total number and cost of the grade crossing eliminations which can be undertaken at this time will be included in the report which is to be sent to every member of Congress. No recommendations are offered as to the relative merits of contract and force account work nor does the association commit itself as to the earmarking of appropriations or the method of control.

Federal Reclamation Declared Sound In Committee Report

FEDERAL reclamation in the west was found to be a "sound and desirable national undertaking" in the report of a committee composed of John W. Haw, director of agricultural development, Northern Pacific Railway, and F. E. Schmitt, editor, *Engineering News-Record*, which made a survey on conditions and problems for Secretary of the Interior Harold Ickes. The report was based on an inspection of typical projects, conferences with authorities and a study of the records of the Bureau of Reclamation.

The committee reported as follows:

1. Reclamation by irrigation of land in the arid and semi-arid western half of the United States is shown by its results to be a sound and desirable national undertaking. It represents a constructive policy of social development.
2. Reclamation should be continued by the Federal Government as available means may permit.
3. Except for the influence of the present depressed farming conditions the operating projects are in the main excellently developed and represent strong, prosperous communities.
4. Present reclamation procedure encounters its most troublesome problems in the financial relations between the water user and the Government. The problems arise from the fact that the Reclamation Bureau, though not a banking agency, is required to carry out the banking function of collecting the installment payments on the cost of the works. The Bureau of Reclamation should be relieved of the responsibility for collection in the case of all future projects. If practicable, the revised collection system should be applied also to the operating projects.
5. In the interests of full and efficient utilization of stream waters, the best plan of development as between different regions in the basin and most efficient arrangement of the individual project, it is desirable that the selection and planning of projects be improved by establishing cooperation with states and by authorizing the Bureau of Reclamation to develop its project plans on the basis of best regional results.
6. For permanent security of irrigated agriculture, future reclamation should, if practicable, include measures that will prevent overdevelopment of land beyond the available water supply. Control of storage should remain in the hands of the Federal Government to assure equitable distribution.
7. A uniform policy to govern power developed or to be developed in connection with reclamation projects should be established by law.

An extended abstract of the report will appear in an early issue.

Program of Seven New Buildings Started at Louisiana University

A construction program to include the erection of seven new buildings will be started at the Louisiana State University, Baton Rouge, early in 1935. According to a statement by the president, the program will include several new dormitories.

Inventory of New Work Projects Being Taken by the PWA

Preparing for the $4,900,000,000 work relief program of President Roosevelt, the Public Works Administration and the National Resources Board are taking a national inventory of projects available for prompt inclusion in the new plan. The survey, being carried out through the agency of PWA state engineers and state planning boards, is being made by direction of the President, who is anxious to have the work stage on a maximum number of projects reached as soon as possible, following the appropriation by Congress.

Construction Code Amendments To Be Considered at Meeting

At a meeting of the Construction Code Authority to be held in Washington on Jan. 25 consideration will be given to a modification of the code provisions relating to area agreements on wages, hours and other conditions of employment. The code now provides that such agreements must be negotiated separately for different divisional chapters, and that an agreement made under one chapter may not bind employers in another. The proposal has been made that joint agreements might be permitted by mutual consent of two or more divisions or sub-divisions. In some regions the specialized contractors are insufficiently organized to negotiate agreements, and the general contractors in some such cases are representative of the particular functions of the industry involved.

Damages Awarded City of Waco In Suit over Pipeline Work

The city of Waco, Texas, has been awarded a judgment of $237,000 against the U. S. Pipe & Foundry Co., in a suit brought by the city in 1932 to recover damages as the result of the failure of a number of lengths of cast-iron pipe in a 5½-mile line built as part of an extension of the city's water supply system. In a cross suit the contractor, the W. E. Callahan Construction Co., was given a judgment of $5,000 against the city. An appeal has been filed.

Suit was brought against the engineers, contractor, pipe company, and surety company in 1932 (*ENR*, Apr. 7, 1932, p. 520). The line in question was of standard 100-ft. head "Hi-tensile" pipe, 15,300 ft. of 42½-in. and 13,075 ft. of 37½-in. diam. After the pipe had been laid and before the 24-hr. pressure and leakage test could be completed, 37 broken pipes were removed, and during the 1-year maintenance period specified in the contract, 20 more broken pipes were removed. At the time of the trial, October and November, 1934, the city had taken out 16 more broken pipes.

The suit included allegations of conspiracy, fraud, and incompetence, the jury being asked "do you find that H. F. McFarland for the W. E. Callahan Construction Co. and D. B. Stokes for the U. S. Pipe & Foundry Co. conspired to unduly influence Floyd & Lockridge to use 'Hi-tensile' cast-iron pipe?" The firm of Floyd & Lockridge were engineers for the city on the work. To the question the jury gave a negative answer.

Contract for 12.7-Mile San Jacinto Tunnel Suspended by Metropolitan District

The $7,339,100 contract for the construction of the 12.7-mile San Jacinto tunnel on the Colorado River aqueduct project, held by the Wenzel and Henoch Construction Co., was suspended by an official statement issued by F. E. Weymouth, general manager and chief engineer of the Metropolitan Water District, on January 15. In the statement, Mr. Weymouth announced that an "experienced construction organization" was prepared to take over and prosecute this tunnel work, and the contractors were requested to make way for these construction forces. The lack of mention of calling for bids indicates that the district may intend to take over the work by its own construction forces which are now driving sections of the aqueduct tunnel by force account.

Situation reviewed

In announcing the suspension of the Wenzel and Henoch contract, Mr. Weymouth issued the following statement:

"The San Jacinto tunnel contract was signed on March 17, 1933, and was to be completed on Dec. 17, 1938, the time when the entire aqueduct is to be completed and water made available for the district.

"Although approximately 30 per cent of the contract period has expired, the work on San Jacinto tunnel is only about 17 per cent completed. The topographic conditions are such that it is necessary to drive 8.2 miles of tunnel between two shafts on this section, and of this 8.2 miles, less than one mile has been excavated. Only 28 ft. of this critical portion was excavated in November, only 127 ft. in December, and none to date in January, as against a rate required for timely completion of at least 800 ft. per month. The contract has been, therefore, suspended because the construction of the tunnel was being unreasonably and unnecessarily delayed.

"Beginning April, 1933, the contractor has repeatedly been urged verbally and in writing to make better progress, but all of these efforts resulted only in promises from the contractor that he would promptly arrange for better progress but without actual improvement. As chief engineer of the Metropolitan Water District, I was, therefore, finally forced to the conclusion that no better results could be expected in the future than in the past. In the interests of the taxpayers, and in order to assure completion of the tunnel, I have suspended the contract and taken over the work.

"Large losses will result to the taxpayers of the District if this tunnel is not completed on time. Except for this one tunnel, the work is going forward according to schedule and in a satisfactory manner. In fact, much of the aqueduct work is well ahead of schedule. In contrast to this, the San Jacinto tunnel is at least seven months behind schedule, and it is imperative that this work be brought up to time.

"It is true that more water has been encountered than was anticipated but not more than a prudent contractor should have been prepared to handle under emergency conditions. Also, some tunneling difficulties have been encountered, but these were not unexpected and could have been amply allowed for by beginning the work promptly after the execution of the contract and prosecuting it vigorously with competent management and adequate equipment.

"The contract price for the San Jacinto tunnel amounted to $7,339,100; in addition to this amount the District would be required to furnish materials, supplies, and engineering, making the total estimated cost $9,000,000.

"Construction problems of the San Jacinto tunnel are not insurmountable. Plans are ready for the vigorous prosecution of the work with an experienced organization."

Second low bidder

Eight construction organizations bid on the San Jacinto tunnel in 1933. The low bidder was the Metropolitan Engineering Corp., Los Angeles, at $7,331,815. Second low was Wenzel & Henoch Construction Co., Milwaukee, at $7,340,100. The next bidder, Metropolitan Construction Co., was more than one million dollars higher at $8,417,725.

Contract was awarded to the low bidder who failed to qualify and the award was subsequently let to the second bidder.

Installation of Crest-Gate On Hawk's Nest Dam Postponed

Installation of crest-gates on the Hawk's Nest dam of the Electro-Metallurgical Co. on the New River in West Virginia may be postponed until Sept. 27, 1939, according to a finding of the West Virginia Public Service Commission made on Dec. 5. This company is successor to the New-Kanawha Power Co., a Union Carbide & Carbon Corp. subsidiary.

Failure to install the crest-gates at this time will not be adverse to the interests of navigation on the Great Kanawha, into which the New River flows, it was testified before the commission.

The power plant of the Hawks Nest development consists of four 35,000 hp., 25 cycle, single phase generators. Before the failure of the penstock of the dam while under test (*ENR* Nov. 8, 1934, p. 604), it was expected that the plant would be put into service about Jan. 1. With the crest-gate installed, the head on the power plant would be 167 ft.

While economic reasons are assigned for the company's request to postpone installation of the gates, it is believed that the federal government's suit to compel the power company to take out a federal license may have had an important bearing upon the company's decision to postpone further expenditures on the project. The preliminary issues were scheduled to be argued on Jan. 7. As noted in our issue of Dec. 13, p. 774, the state of West Virginia will intervene as it supports the power company's claim that the New River is not navigable and so this plant is outside of the federal jurisdiction. It is expected that the suit will be a protracted one as an effort will be made to take the case up to the United States Supreme Court, previous attempts to get it before the Court having failed.

CONNECTING DENMARK WITH EUROPEAN MAINLAND

Rapid progress is being made on the combined railway and highway bridge connecting Denmark's island of Funen with the Jutland peninsula on the mainland of Europe. Spanning the strait known as the Little Belt, the bridge will greatly expedite traffic to and from Copenhagen, which is located on the island of Zealand, east of Funen across another strait known as the Great Belt.

The Little Belt Bridge, costing about $9,000,000, consists of five steel spans varying 451 to 722 ft. in length over the 2,700-ft. channel, and is flanked by concrete-arch approaches. The bridge is notable not only economically but technically. It involves the use of 15,000 tons of copper-silicon steel. Its foundations were built in more than a 100-ft. depth of water by unique pipe-wall open caissons. The foundations and the truss-erection plans were described in *ENR*, Oct. 13, 1932, p. 427. The Little Belt Bridge is being built under the direction of the Danish State Railways. A. Engelund is chief engineer. The contractors are the Danish firm of Monberg & Thorsen, and the German firms of Fried. Krupp, Grun & Buffinger, and Louis Eiters.

Retention of Selling-Below-Cost Provision Urged by Construction Code Authority

RETENTION of selling-below-cost provisions and cost accounting systems in chapters of the construction code and adequate enforcement of both were asked of the National Industrial Recovery Board in its hearing in Washington, Jan. 9-12 by representatives of the Construction Code Authority and several divisional code authorities. The construction code contains no price fixing provisions, the code authority pointed out to the Recovery Board and the selling-below-cost provisions in several of the chapters are entirely outside this category. The very nature of the construction industry does not lend itself to price fixing or control, it was stated.

The selling-below-cost provisions in the code, the code authority declared, are primarily for the protection of the contractor and the consumer in that they provide a check that the proper quantities have been figured, that the bidder will use the type, quality and kind of material that is specified for a project, that there will be greater adherence to plans and specifications, and that the contractor will not lose on the job.

Protest 15 per cent order

The Construction Code Authority also joined in the protest against the 15 per cent executive order allowing governmental agencies to buy goods and services as much as 15 per cent below the price filed with the code authorities in such industries which have open price filing systems.

The prohibition against selling below cost or provisions for standard cost accounting systems are not included in Chapter I of the Construction Code—the general provisions. However, ten of the twenty chapters governing divisions of the industry do contain selling-below-cost provisions and twelve require standard cost accounting systems. Chapter II of the Code, for General Contractors, does not contain provisions for either.

A return to the cut-throat competitive system would have a devastating effect on labor rates, it was claimed, and representatives of other industries supported this contention adding that such a return would force them to reduce wages below minima provided in the various codes. A preponderance of the testimony offered the Recovery Board by nearly 200 witnesses from as many codified industries was in favor of some type of price stabilization whether it was open price filing systems, stop-loss provisions or selling-below-cost provisions.

Cement Bids for Muskingum Dam Rejected as Too High

The 19 bids received by the U. S. Engineers for supplying cement for five dams on the Muskingum Valley conservancy project have been rejected "due to prices being considered excessive." All bids were identical.

The amount of cement involved is relatively small, as the structures are earth-filled dams and the concrete work is for incidental structures. The amount of cement for individual dams varies from 5,500 bbl. for Tappan dam as a minimum, to 30,000 bbl. for the Beach City dam.

General Contractors Approve Change In Code

A PROPOSED amendment to the Construction Code to provide for inter-divisional code agreements with respect to assessments was approved by the Divisional Code Authority for General Contractors at its meeting in Washington on Jan. 14 and 15. The proposed amendment would provide that: "Every member of a division shall be exempt from any obligation to contribute to the expense of administration of any division other than the division which embraces his principal line of business. This provision shall not prohibit inter-divisional agreements by the respective divisional code authorities describing other conditions for contributions. Such agreements shall be filed with the Construction Code Authority and the National Recovery Administration. If no agreement can be reached, any divisionsal code authority having an interest may submit the controversy to the Construction Code Authority for decision."

Five agreements approved

In line with the proposed amendment, the Divisional Code Authority approved five proposed inter-divisional code agreements which have been submitted to it by the Cement Gun Contracting Division, Tile Contractors Division, Marble Contracting Division, Heating, Piping and Air Conditioning Division and the Building Granite Division. The executive committee was voted authority to pass on such future inter-code agreements as may be submitted.

Approval was also given to the proposed amendment to Chapter I of the code, which would permit two or more divisions or subdivisions of the industry to enter into joint mutual area agreements in regard to wage scales. It was reported that to date, there has been a total of 216 area agreements submitted to NRA for approval, and that eleven have been approved. Public hearings have been held on 53 agreements and dates have been set for hearings on 12 others.

SOCIETY CALENDAR

ASSOCIATED GENERAL CONTRACTORS, annual convention, Washington, D. C., Jan. 28-30.

CANADIAN CONSTRUCTION ASSOCIATION, annual convention, Montreal, Que., Jan. 29-31.

ENGINEERING INSTITUTE OF CANADA, annual meeting, Toronto, Ont., Feb. 7-8.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Indianapolis, Ind., Feb. 7-8.

AMERICAN CONCRETE INSTITUTE, annual meeting, New York City, Feb. 20-22.

AMERICAN SOCIETY FOR TESTING MATERIALS, regional meeting, Philadelphia, Mar. 6; annual meeting, Detroit, June 24-28.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Cincinnati, Ohio, May 6-10.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS, annual meeting, New Haven, Feb. 19-20.

INDIANA SECTION, American Water Works Association, Indianapolis, Mar. 7-8.

CANADIAN SECTION, American Water Works Association, London, Ont., Mar. 27-29.

Administration Work Relief Placed Before the House

(Continued from p. 138)

land and property, employing personnel under the bill without recourse to civil service regulations.

Possible administrators

The question of the administration of the fund is still purely conjectural but the President's message indicated that a new central authority would be set up. Those venturing any guesses are of the opinion that a board will be at the top—possibly including Richberg, Hopkins, Morgenthau, Ickes, and other prominent New Deal leaders. A one-man control, however, still is possible or a coordinator in active charge under supervision of a board.

The scope of employment to be sought under the program is indicated by a statement of Harry L. Hopkins to the effect that the 3,500,000 men mentioned by the President does not mean an increase by that amount but a total figure for work relief in 1935-36. Present work relief is carrying 2,250,000 and the proposed total would raise this figure by 1,250,000, according to Mr. Hopkins' interpretation. At present the PWA and CCC each are carrying about 400,000 in terms of direct employment. Plans are under way to double the CCC. The PWA totals are expected to increase through the year under existing allotments. Municipal work under PWA is expected to increase, offsetting a decline in federal and railroad work of PWA.

Of the work relief type of activity, CCC is susceptible to quickest expansion. Highway work may be developed most rapidly in terms of heavy construction. A survey made by the American Association of State Highway Officials among the 48 states indicates a total of $691,000,000 in definite projects which can be started quickly and an additional $1,007,000,000 which can be started within a year.

Funds for highways

Chairman Cartwright of the House Committee on Roads has introduced a bill to set aside $400,000,000 for highways and $300,000,000 for grade crossing eliminations to be handled under the Secretary of Agriculture through the Bureau of Public Roads. Arthur W. Brandt, president of the American Association of State Highway Officials, has endorsed the bill in hearings before the committee.

Bids Called for Construction of $4,850,000 Irrigation Work

Bids will be opened Feb. 11 for the construction of irrigation works for the Willacy County Water Control and Improvement District No. 1, Raymondville, Tex., estimated to cost $4,853,000. The cost of the project is covered by a loan and grant from the PWA secured by bonds of the district. Construction work would provide employment for 4,000 men for an 18-month period, according to officials of the district. The project would reclaim about 70,000 acres of land.

Casper-Alcova Project Held To Be Legally Unsafe

(Continued from p. 138)

struction of the project, subject to certain conditions. The approval states that "This permit is issued subject to all rights which are vested and approved under the laws of Wyoming, as of this date (Sept. 14, 1934), to the use of the water of the North Platte River and its tributaries above the Pathfinder Dam."

After reviewing the pertinent sections of the Wyoming statutes on the appropriation of public water, in the light of the conditional permit, Solicitor Margold stated: "It is my opinion that the permit of Sept. 14, 1934, was not issued in consonance with law, and that the United States cannot safely proceed with the project which that permit purports to authorize."

The opinion of the solicitor states further: "The action which the state engineer has taken is neither an approval nor a rejection of the application in question. It does not permit an appropriation with such priority as is fixed by statute. On the other hand it does not reject the application. The engineer has not exercised his judgment upon or decided the issues which he is authorized to decide. Such action cannot be relied upon as an adequate one for construction of the proposed project."

Subsequent rights

The remainder of the opinion discusses the position of the subsequent appropriators who have perfected rights in the State of Wyoming between 1904 and the filing of the amended applications in 1934. These appropriations, according to Wyoming law, would have strong legal claim against giving the amended application a priority as of 1904. Further, there is the question of appropriators in the State of Nebraska who have perfected rights during the same period and who might contest the federal permit. This interstate problem of water rights would require U. S. Supreme Court ruling.

"In summary," says Solicitor Margold, "it is my opinion that the permit of Sept. 14, 1934, is not a lawful authorization; that it is doubtful whether litigation will result in the attainment of a 1904 priority for the project; that if it is administratively decided to continue with the project, the proper procedure at this time is a vigorous prosecution of the pending appeal and the encouragement of litigation in the Supreme court to settle interstate water rights; and that under any circumstances construction should not proceed at this time if the 1904 priority is essential to the project."

Another Tunneling Record Set On Colorado River Aqueduct

During the month of November crews of the Walsh Construction Co., driving the Copper Basin tunnel No. 2 on the Colorado River aqueduct project of the Metropolitan Water District, drove 1,084 ft. in one heading. This tunnel is located near the river on the eastern end of the project. During the 30-day period from Nov. 16 to Dec. 15, in the same heading, this figure was increased to a new record of 1,111 ft. This footage, an average of 12.3 ft. per shift, represents a record for tunnel driving work on the aqueduct.

Karl Imhoff Resigns Post With German Drainage District

Dr. Karl Imhoff has resigned as chief engineer of the Ruhrverband in Essen, Germany, and has established a consulting engineering office at Hauptpostgebäude, Essen, Germany. Dr. Imhoff is internationally known through his development of sewerage and sewage treatment methods in two of the great sanitary districts of Germany. From 1906 to 1922 he was sewerage engineer of the Emschergenossenschaft in Essen, which has jurisdiction over the hydraulic and sanitary control of the drainage basin of the Emscher, a tributary to the Rhine River, which traverses the great coal mining region of the Ruhr district.

In 1913, he established the Ruhrverband and directed its activities until his retirement in 1934. This organization has hydraulic and sanitary control over the catchment area of the Ruhr River, a stream which is used as a source of water by almost three and a half million people and receives the drainage from a population of almost one and a half million. One of the great undertakings of the district during the last years of Dr. Imhoff's connection with it has been the development of impounding reservoirs in the Ruhr valley, which combine the sanitary reclamation of the stream, its economic exploitation for water power purposes and the development of recreational facilities.

Personals

ROBERT E. L. KNAPP, for several years Skagit county engineer, has returned to that position, which he left about a year ago.

WILLIS C. BICKFORD, consulting engineer and formerly building superintendent of Seattle, Wash., has been appointed general manager and chief engineer of the Port of Seattle.

HUBBARD E. RUDY, construction superintendent of the Kentucky highway department, has been appointed assistant county engineer of Louisville County, succeeding Chester Adams, who resigned following his appointment as a member of the state highway commission.

A. L. ALIN is chief designing engineer of dams with the U. S. Engineers, Zanesville, Ohio, at work on the Muskingum Conservancy District program. Mr. Alin attended the World Power Conference in Stockholm in 1933 and subsequently studied European methods of dam design and construction.

THOMAS W. HARVIE, general manager of the Port of Montreal, retired Jan. 1, after serving the port for almost 25 years. Mr. Harvie became connected with the Port of Montreal as assistant engineer early in the century, later served as resident engineer on the construction of the Victoria Basin, was named chief engineer in 1922, and later was appointed general manager.

NATHAN L. SMITH, associate engineer in the department of public works, Baltimore, Md., has been appointed temporary chairman of the Maryland State Roads Commission. The commission, according to report, is to undergo extensive reorganization, and following these changes the governor plans to appoint Mr. Smith chief engineer of the commission. From 1925 to 1927 Mr. Smith was assistant highway engineer of Baltimore, and later served as highway engineer for the city. Since that time he has been an associate engineer in the department of public works of the city.

Obituary

Frederick H. Cook, for many years consulting engineer of the Holyoke Water Power Co., died at his home in Holyoke, Mass., Jan. 16, at the age of 75.

W. C. Adams, consulting engineer and previously chief engineer of the Northern Electric Co., Ltd., Montreal, Canada, died in that city Jan. 6. He was a graduate of the University of Minnesota in 1905, and had been associated with the Western Electric Co., in New York, before moving to Canada, about 15 years ago.

Joseph E. Jensen, associate highway engineer, Bureau of Public Roads, died Dec. 27, at Ashland, Ore. He had been in the government service as early as 1911, when he served as district ranger for the Forest Service. He returned to the Bureau of Public Roads, following the war, as a transitman, and rose to the rank of associate highway engineer in District No. 2, San Francisco, Calif. He was 47 years of age.

George Marshall Ames, engineer and vice-president of the construction firm, Owen, Ames & Kimball, Grand Rapids, Mich., died at his home, January 16. He was 76 years of age. Mr. Ames studied engineering at the University of Michigan, leaving the institution in 1885 to work on railroad surveys. He served for several years as city engineer of Grand Rapids, leaving the city employ in 1900 to join contracting firm of Hauser, Hayden & Owen; he subsequently bought into this firm.

Harry F. Ferguson, chief sanitary engineer, Illinois Department of Health and technical secretary of the Illinois Sanitary Water Board, died suddenly in a hospital in Chicago on Jan. 16. Born in 1889 in Adams, Mass., he spent three years at Trinity College, Hartford, Conn., and then was graduated from Massachusetts Institute of Technology in 1912. Beginning his engineering career as a rodman and instrument man with the sewer division of Boston he was for a short time with the Pennsylvania R. R. at Fort Wayne, Ind. He came to the Illinois State Water Survey in 1912 as third assistant engineer and rose successively through second, first and principal assistant engineer until 1919 when he became principal assistant engineer to the Illinois Department of Health. Since 1920 he had been chief sanitary engineer. Since 1924 he had been trustee of the Springfield Sanitary District. He served from 1917 to 1919 as first lieutenant of engineers, U. S. Army, in France during the war. As an author he was a frequent contributor to *ENR* and other magazines on health and sanitary subjects.

CONSTRUCTION STATISTICS OF THE WEEK

HIGHER private and federal awards bring this week's total engineering construction up to $25,295,000, of which $5,819,000 is for private work and $19,476,000 for public construction. Of the latter, $7,344,000 is for federal and $12,132,000 for state and municipal work.

The increase is principally in earthwork and waterways which total $4,243,000 for the week and in unclassified, $3,523,000. Other classes of work include: waterworks, $1,090,000; sewerage, $723,000; public buildings $6,418,000; commercial buildings **$1,741,000**, an increase over last week; industrial buildings, $1,185,000; streets and roads, $5,170,000; and bridges, $1,299,000.

The larger awards for the week include: Theater, Houston, Tex., $650,000; dining hall and barracks, Veteran's Hospital, Togus, Me., $784,000; Contract 23 for Techwood Housing Project, Atlanta, Ga., $2,108,000; highway awards by Illinois, $1,764,000 and by Kansas, $938,000; Dam 10, Mississippi River, Guttenberg, Ia., $1,946,000; 32,000 tons steel rails, Norfolk and Western Ry. Co., Roanoke, Va., $1,050,000, and 1,000 ft. coal pier, Norfolk and Western Ry. Co., Norfolk, Va., $1,600,000.

New capital is higher with $11,332,000 in state and municipal bond sales and net additions to non-federal PWA allotments outstanding of $5,314,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Jan. 1934	Average Prev.4 Weeks	Week Jan.24 1935
Federal Government	$15,532	$4,607	$7,344
State and municipal	14,321	15,848	12,132
Total public	$29,853	$20,455	$19,476
Total private	3,542	2,843	5,819
Week's total	$33,395	$23,298	$25,295

Cumulative to date:
1934...$133,581,000 1935...$101,342,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

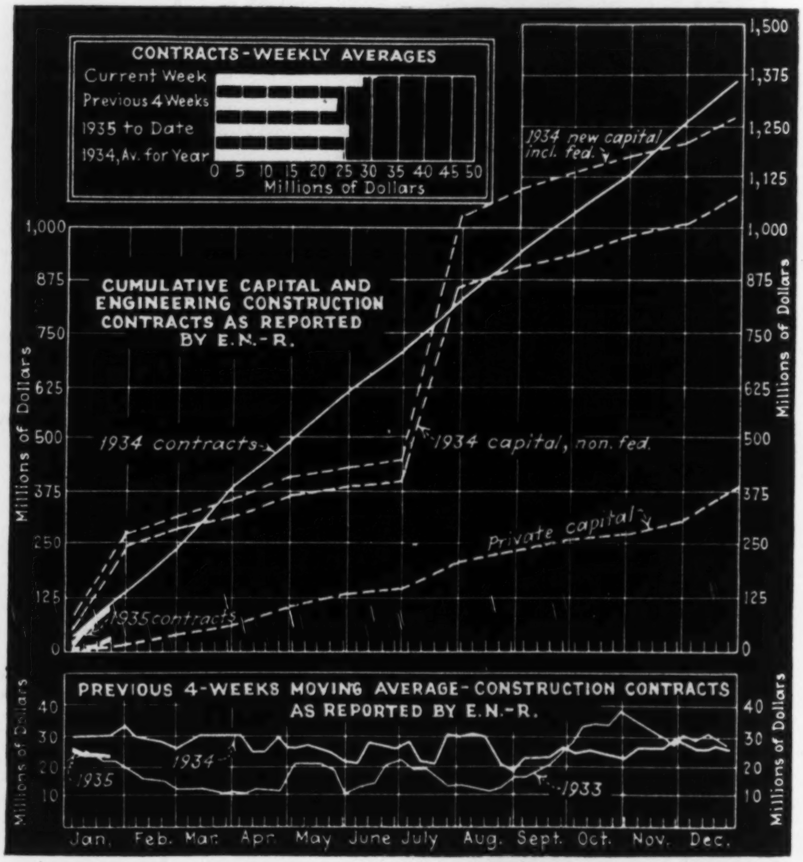
1934	Week Jan.24	Cumulative
State and municipal.....	$11,332	$26,724
PWA allotments, S&M...	2,948	379
RFC loans, S&M........	....	....
Corporate issues	....	....
PWA allotments, private	2,366	2,366
Total, Non-Federal....	$16,646	$29,469
PWA allotments, Federal Constr.	695	2,531
Total new capital.......	$17,341	$32,000

Cumulative to date:
1934...$269,129,000 1935....$32,000,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

INDEX NUMBER

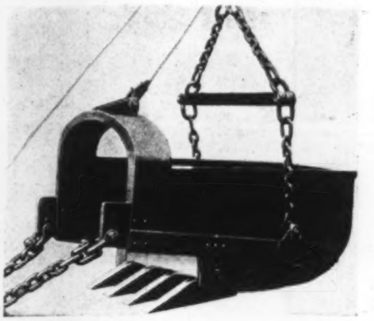
E.N.-R.- Cost	1913 = 100	1926 = 100	E.N.-R.- Volume	1913 = 100	1926 = 100
Jan., 1935...	**198.72**	**95.52**	**Dec., 1934...**	**105**	**46**
Dec., 1934...	201.86	97.03	Nov., 1934...	115	50
Jan., 1934...	191.26	91.94	Dec., 1933..	116	51
1934 (Av.)...	198.10	95.23	1934 (Av.)..	114	50
1933 (Av.)..	170.18	81.80	1933 (Av.)..	102	47
1932 (Av.)...	156.97	75.45	1932 (Av.)..	127	56



Construction Equipment and Materials

All-Welded Construction Used On New Lightweight Bucket

A new lightweight bucket, designed to reduce dead weight to a minimum and at the same time provide adequate strength through all-welded construction, has just been announced by the Harnischfeger Corp., Milwaukee, Wis.



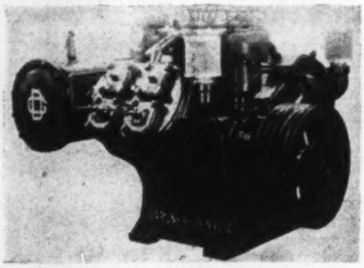
Harnischfeger's new light-weight bucket

The bottom, sides and back of the new bucket are formed by a single heavy steel plate seamed at the back and with a heavy angle reinforcement mounted around the upper edge for additional rigidity. Four forged wearing shoes or runners are welded to the bottom to take the wear from the bucket shell. The arc and side reinforcements are fabricated as a single unit with the lip plate, the latter being 2 in. thick.

Water-Cooled Compressor Has Four Low-Pressure Cylinders

A new 6-cylinder two-stage water-cooled compressor, for which there is claimed superiority in regard to delivery, power consumption and durability, has been announced by the Gardner-Denver Co., Quincy, Ill.

An outstanding departure from conventional compressor design is the use of four small-diameter low-pressure cylinders, instead of two large ones, the manufacturer explaining that this construction permits the use of small, light-weight pistons and reduces considerably the inertia loads. The use of two pairs of low-pressure water-cooled cylinders provides lower air temperatures than previously obtained in small vertical compressors, with corresponding saving in horsepower. By water-cooling the cylinder walls, lower wall temperatures are obtained with better lubrication and longer life.



Two-stage compressor with four small low-pressure cylinders

Mountings include motor mounted on shaft; V-belt to electric motor, diesel or gasoline engines; or direct-connected through flexible flywheel coupling to motor and engines.

New Equipment in Brief

Hammer Drills. Brush Nail Expansion Bolt Co., Greenwich, Conn., announces the double ended hammer drill, which comprises a twist drill pointed at each end, a holder and a collet to protect the unused point.

Welding Machine. The Ideal Electric & Manufacturing Company, Mansfield, Ohio, announces a new design of arc welder for which it is claimed increased efficiency and a fast arc with rapid recovery speed. The machine is designated the Noel Speed Arc welder. The machine provides both 25 and 40 volt operation.

Power Shovel. The Koehring Co., Milwaukee, Wis., announces the new 801, 2-cu.yd. shovel. This machine is convertible to either crane or dragline and is furnished with gasoline, diesel, oil or electric power. It has the independent and positive chain or cable crowd, and is equipped with a high strength welded shovel boom.

Blueprint Paper. The C. F. Pease Co., Chicago, Ill., announces the Pease "K" speed blueprint paper and cloth, which the manufacturer states is "non-bleeding." With the new paper prints may be fully exposed and still produce a deep blue color and permit the white to stand out in sharp contrast.

Spray Guns. Two new spray guns, "Thor" Models 5 and 6, have been announced by the Binks Manufacturing Co., Chicago, Ill. The first is a touch-up and shading gun, and the second is a combination touch-up and general service gun. The spray is readily adjustable, while the gun is being used, by means of a screw on the side just behind the nozzle head.

Industrial Locomotive. Davenport Locomotive Works, Davenport, Iowa, announces a new series of industrial gasoline and diesel geared locomotives ranging in capacity from 2½ to 25 tons. The manufacturer states that they have a wide range of speeds and are capable of maximum hauling power at speeds as low as 2½ to 3 miles per hour, according to the size of the unit.

Excavating Machine. The Osgood Company, Marion, Ohio, has announced a new 1¾ cu.yd. power excavator, designated the Osgood Chief. It is designed for use as a shovel, dragline, clamshell, or crane, and is readily converted in the field from one class of service to the other. The boom is a single steel member, box section, with steel diaphragms and with large foot castings.

Air Hose. A new type of air hose has been introduced by The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc., Passaic, N. J. The manufacturer states that the construction of the hose compensates the unequal ply stresses set up in the wall by longitudinal and lateral tension. It consists of two strength members, a braided cord member for longitudinal stresses and a spiralled strength member for expansion and lateral stresses, both welded in rubber.

New Publications

CORROSION AND HEAT RESISTING STEELS, Crucible Steel Co. of America, New York, N. Y. 8½x11, 80 pages.

DRILLING AND FISHING TOOLS, Bucyrus-Armstrong, Bucyrus-Erie Co., South Milwaukee, Wis. 8½x11, 48 pages.

MINING AND CONTRACTORS TOOLS, Independent Pneumatic Tool Co., Chicago, Ill. Catalog No. 40, including information on paving breakers, stopers, mountings, excavating, tamping and surfacing tools, sump pumps and other tools.

SHEET IRON, A PRIMER, Republic Steel Corp., Youngstown, Ohio. 5½x7½, 4 pages.

PRECAUTIONS AND SAFE PRACTICES, Linde Air Products Co., New York, N. Y. 9x7, 24 pages.

RECOMMENDED PRACTICES, Linde Air Products Co., New York, N. Y. 5½x8, 16 pages. Gas cutting for structural steel.

WELDING ELECTRODES AND ACCESSORIES, General Electric Co., Schenectady, N. Y. 8½x11, 16 pages.

ARC WELDERS, General Electric Co., Schenectady, N. Y. 8x10, 12 pages.

JAEGER LAKEWOOD EQUIPMENT, Jaeger Machine Co., Columbus, Ohio. 8x9, 36 pages.

Business Notes

ILLINOIS STEEL CO., Chicago Ill., announces that Griswold A. Price has been appointed manager of sales of their St. Louis district.

CANADIAN SULLIVAN MACHINERY CO., LTD., supersedes the Sullivan Machinery Co., Ltd., in Canada in the sale of Sullivan core drills, rock drills, air compressors, slusher hoists, etc.

BROWN INSTRUMENT CO., Philadelphia, Pa., announces a consolidation with the MINNEAPOLIS-HONEYWELL REGULATOR CO. of Minneapolis, Minn. THE BROWN INSTRUMENT CO. will continue as a separate company with its existing organization but as a subsidiary of MINNEAPOLIS-HONEYWELL REGULATOR CO.

TONCAN CULVERT MANUFACTURERS' ASSOCIATION announces the appointment of H. N. Pickett as advertising manager.

UNIVERSAL ATLAS CEMENT CO., Chicago, Ill., announces the appointment of W. H. McDowell as sales manager of the Kansas City office.

Power Concrete Vibrator Driven by Gas Engine

By utilizing a variable speed 2-hp. gas engine to operate an internal type of concrete vibrator isolation of the job from an air or electricity supply is possible. This outfit recently put out by the Mall Tool Company, Chicago, Ill., is made up of a vibrator 2⅜ in. in diameter by 18 in. long with a flexible shaft to the portable gas engine. The vibrators are immersed in the concrete to any depth desired by adding suitable lengths of flexible shafting in units of 7 ft. each. The outfit comes with a 14-ft. length of shaft.

Internal concrete vibrator driven by gas engine

Current Construction Unit Prices

Hydraulic Fill for Quabbin Dike

ONE OF THE largest earth dams in the East to be built by the full hydraulic method, Quabbin Dike, was placed under contract on Nov. 26, 1934, by the Metropolitan Water Supply District of Boston. The dike, which consists of an earth embankment of 2,100,000 cu.yd., is one of two large earth dams required to create Quabbin Reservoir on the Swift River. Quabbin Dike will close off a gap between two hills on the side of the Swift River valley. The other dam, on Swift River, is yet to be built, though diversion works at the site were completed two years ago. A 24-mile tunnel connecting the proposed Quabbin Reservoir with the present Wachusett Reservoir, tapping Ware River enroute, has been completed. Under a previous contract at Quabbin Dike recently completed, a concrete corewall of pneumatic caissons was sunk along the centerline of embankment. The contractor for this work, West Construction Co., was second low bidder for the embankment. The contractor for the embankment will have his choice of three methods of placing the fill: (1) Full hydraulic placement by pipeline from the borrow pits; (2) full hydraulic placement from hog boxes at the site of dam, with truck haul from borrow pits to hog boxes; (3) same with railroad haul from borrow pits.

Following are complete unit prices of the three lowest bidders out of six. Frank E. Winsor, as chief engineer of the Commission, will be in charge. (A) Arthur A. Johnson Corp., Long Island City, N. Y. (contract) $1,446,655; (B) West Construction Co., Boston, $1,511,903; (C) S. J. Groves & Sons Co., Minneapolis, $1,816,450.

EMBANKMENT DIKE FOR QUABBIN RESERVOIR

Item and Quantity	Unit Prices A	B	C
1. Clearing and grubbing—150 acres	$240.00	$50.00	$150.00
2. Earth excavation—50,000 cu.yd.	.30	.30	.75
3. Rock excavation, core wall—12,000 cu.yd.	2.60	3.20	4.00
4. Other rock excavation—6,000 cu.yd.	2.00	2.00	2.00
5. Previous Fdn. embankment—175,000 cu.yd.	.35	.50	.50
6. Rolled impervious core embankment—60,000 cu.yd.	.45	.60	.75
7. Other rolled impervious embankment—85,000 cu.yd.	.40	.59	.75
8. Hydraulic fill embankment—2,100,000 cu.yd.	.39	.405	.50
9. Misc. embankment—10,000 cu.yd	.26	.30	.40
10. Selected coarse material—100,000 cu.yd	.65	.48	.50
11. Crushed stone or screened gravel—20,000 cu.yd.	.90	1.10	1.75
12. Light riprap—100,000 cu.yd	1.05	1.10	1.25
13. Heavy riprap—19,000 cu.yd	1.45	1.75	2.25
14. Paving—1,200 cu.yd.	7.00	3.00	4.00
15. Soil dressing—40,000 cu.yd.	.70	.95	.75
16. Seeding and grassing—30 acres	250.00	120.00	175.00
17. Gravel sub-base for roads—6,000 cu. yd	1.00	.43	.70
18. Broken stone base for roads—1,800 cu.yd	4.00	2.85	3.25
19. Broken stone surface for roads—2,500 tons	4.25	2.60	3.75
20. Bituminous material—40,000 gal	.20	.16	.15
21. Cable guard rail—1,500 lin.ft	2.00	.60	1.00
22. Boulder guard rail—1,000 lin.ft.	1.00	3.00	1.00
23. Stone walls—1,400 cu.yd.	8.50	3.60	10.00
24. Drill holes in rock or masonry—2,500 lin.ft.	.60	1.75	1.00
25. Furnish and place grout—1,000 cu.yd	9.50	9.50	30.00
26. Prepare rock surface—1,500 sq.yd.	.60	4.85	1.00
27. Portland cement—10,000 bbl.	2.85	2.45	2.50
28. Concrete, Class A—2,500 cu.yd	10.00	13.25	10.00
29. Concrete, Class B—50 cu.yd.	15.00	13.25	20.00
30. Reinforcing steel—5,000 lb	.06	.05	.10
31. Misc. steel and iron—60,000 lb	.10	.15	.08
32. Misc. bronze, brass, copper—1,000 lb.	.60	.35	.75
33. 12-in. tile pipe—5,000 lin.ft.	1.20	2.40	1.75
34. 18-in. tile pipe—700 lin.ft.	2.40	3.50	2.00
35. 24-in. tile pipe—200 lin.ft.	4.00	6.70	2.25
36. Sampling wells—2,000 lin.ft	1.20	5.60	.85
37. Maintain engineers' office—45 months	100.00	125.00	25.00
38. Remove brook diversion and caisson equipment	1,000.00	950.00	2,000.00
39. Clean up (lump sum)	12,000.00	1,250.00	5,000.00

Widespread Bids for Sag Channel Excavation

BIDS opened by the U. S. District Engineer, Chicago, on Dec. 29, 1934, for the construction of three passing places on the Calumet Sag Channel west of Blue Island, Ill., revealed an unusually wide spread in prices for excavation and riprap. Proposals were taken on three sections of the work, and an opportunity was provided for submitting bids on all three sections. Three classes of work are scheduled for Sections I and III—common excavation, rock excavation and riprap. Section II has no rock excavation. Bids for common excavation ranged from 15c. to 70c.; on rock from 58.5c. to $2.90. Riprap varied from 60c. to $3.00 per cu.yd. Many of the bids were apparently unbalanced, one firm bidding the same for rock and common excavation, 58.5c. Contract has been awarded to the Morrison-Knudsen Co., Boise, Ida., which submitted one bid for all three sections aggregating $703,827. In the following tables are given the list of bidders and amount of total bids and complete unit prices. Lt.-Col. D. H. Connolly is District Engineer.

CALUMET SAG CHANNEL PASSING PLACES—LIST OF BIDDERS AND TOTALS OF BIDS

	Bidders	Section I	Section II	Section III	Sections I, II and III
A.	Walter S. Rae, Pittsburgh, Pa	....	....	....	$994,525.50
B.	Morrison-Knudsen Co., Boise, Idaho (contract)	....	....	....	703,827.00
C.	Al Johnson Const. Co., Minneapolis, Minn	$237,288.00	$154,982.50	$417,123.00	775,034.00
D.	Brodrick Bros., Villisca, Iowa	....	179,066.00	....	....
E.	Powers-Thompson Const. Co., Joliet, Ill	347,540.00	....	....	....
F.	John Marsch, Inc., Chicago, Ill	....	....	459,486.00	....
G.	Thomas McQueen, Forest Park, Ill	....	....	647,275.00	....
H.	R. C. Huffman Const. Co., Buffalo, N. Y	....	239,462.00	....	....
J.	American Aggregates Corp., Greenville, O	257,570.00	125,583.00	393,765.00	....
K.	S. J. Groves & Sons Co., Minneapolis, Minn	552,900.00	385,795.00	726,580.00	....
L.	Lyons Construction Co., Whitehall, Mich	....	98,445.00	....	....
M.	Engineer's Estimate	260,130.00	162,434.00	502,082.80	906,167.40

COMPLETE UNIT PRICES—CALUMET SAG CHANNEL PASSING PLACES

Item	Description	Quantity	A	B	C	D	E	F	G	H	J	K	L	M
	Section I													
1.	Common Exc	317,000 cu.yd.	.....	.....	$0.24	.....	$0.36	.....	.....	.....	$0.25	$0.70	.....	$0.314
2.	Rock Exc	114,800 cu.yd.	.....	.....	1.30	.....	1.65	.....	.....	.....	1.40	2.50	.....	1.344
3.	Riprap	17,600 cu.yd.	.....	.....	.68	.....	2.50	.....	.....	.....	1.00	2.50	.....	.358
	Section II													
4.	Common Exc	452,300 cu.yd.	.....	.....	0.275	$0.22	.....	.....	.....	$0.34	.21	0.65	$0.15	0.332
5.	Riprap	30,600 cu.yd	.....	.....	1.00	2.60	.....	.....	.....	2.80	1.00	3.00	1.00	.401
	Section III													
6.	Common Exc	506,900 cu.yd.	.....	.....	0.42	.....	.....	$0.44	$0.45	.....	0.35	0.70	.....	0.532
7.	Rock Exc	135,300 cu.yd.	.....	.....	1.45	.....	.....	1.50	2.90	.....	1.50	2.50	.....	1.682
8.	Riprap	13,400 cu.yd.	.....	.....	.60	.....	.....	2.50	2.00	.....	1.00	2.50	.....	.361
	Sections I, II, & III													
9.	Common Exc	1,276,200 cu.yd.	$0.585	$0.21	0.31	.....	.....	.....	.....	.....	.....	.....	.....	0.40
10.	Rock Exc	250,100 cu.yd.	.585	1.25	1.32	.....	.....	.....	.....	.....	.....	.....	.....	1.49
11.	Riprap	61,600 cu.yd.	1.65	2.00	.80	.....	.....	.....	.....	.....	.....	.....	.....	0.374